THE

ENGINEERING MAGAZINE

VOL. XII. JANUARY, 1897. NO. 4.

THE PARAMOUNT CONTROL OF THE COMMERCE OF THE WORLD.

By Edward Atkinson.

I AM asked to write an introductory chapter for a "Prosperity Number" of THE ENGINEERING MAGAZINE. That opens a broad question. What is prosperity? What is necessary to its attainment in the aspect of the conditions which exist at the present writing?

We are dealing with the material conditions on which our life on this planet rests. Existence depends wholly upon food, fuel, clothing, and shelter. All that any one, rich or poor, can get, in a material sense, out of life is his board and clothing. The whole process of the production and distribution of what is called wealth is conducted for the single purpose of providing the materials of existence for consumption. Consumption and reproduction are the end and aim of all trade and industry. Provision must be made every day for what every man must have, be he rich or be he poor. In these modern days it has become the admitted duty of society to provide the necessary food, fuel, shelter, and clothing for paupers who have become incapable of providing for themselves. Food, fuel, shelter, and clothing are all that, in a material sense, the richest man can provide for himself.

What we now call society in this country consists of about seventy-three million human beings. Each one must be supplied every day with two-and-one-half to five pounds of food-material, with fuel wherewith to cook it, and with a certain amount of textile fabrics or furs, and with some boards to put over his head.

The world, as a whole, is always within about one year of starva-

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tion, within two or three years of becoming naked, and within a very few years of becoming houseless. In this country nearly two million human beings are added every year to our population. That number would soon crowd existing dwellings to death, unless in each year about a half-million men were occupied in adding to the number of dwellings already existing.

We call ourselves very rich. We gloat over the billions of dollars' worth of property disclosed by the figures of the census. In 1890 the computation reached the huge sum of over sixty-five billions of dollars. Only think of it! How rich we are! But what does it all come to? About one-third of this valuation is the estimated value of the land on which capital has been placed. Land is our endowment, not our creation. If we deduct a reasonable sum for land valuation, what is left is the capital of the community,—about forty-five billion dollars. This is an estimate in dollars of what we have saved and put to purposes of enjoyment or future use in more than a century of existence as a nation. Again, this is a stupendous sum. What does it amount to?* If the value in money of all that we consumed—food, fuel, shelter, and clothing—in the census year, figured at retail prices, was equal to fifty cents a day per person, then the product of the census year reached a valuation in terms of money, in round figures, of eleven and one-half billion dollars.

That sum was equal to twenty-five per cent. of our whole capital. It was probably more. If we add what is consumed where it is produced, but not sold, and that part of the product which is taken by taxation, then we may reach sixty cents' worth a day,—denoting an annual product worth, in terms of money, two hundred and nineteen dollars a year to each person, and a total valuation in the census year, in round figures, of close upon fourteen billion dollars. We have saved, in all, a little over seven hundred dollars' worth of property, on the average, to each person, and we must consume, in order to

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*Census Valuation, 1890.

Real estate and improvements	$39,544,544,333
Mines, quarries, and product	1,291,291,579
	$40,835,835,912
Deduct one-half for land	20,417,917,956
	$20,417,917,956
Railroads and equipment	8,685,407,323
Telegraph, telephone, shipping, and canals	701,755,712
Machinery, mills, and product on hand	3,058,593,441
Gold and silver coin and bullion	1,158,774,948
Live stock on farms, implements, and machinery	2,703,015,040
Miscellaneous	7,893,708,821
	$44,619 173,241

live, nearly two hundred dollars' worth of product,—probably more.

In other words, in a little over a century of existence as a nation, and in less than a century of union under a constitution, we have succeeded in saving products of human labor in the form of public buildings, warehouses, workshops, factories, railways, vessels, dwellings, tools, machinery, and goods and wares on the way from the producer to the actual consumer, to the amount of a little over seven hundred dollars' worth per head. We consume every year nearly a third as much as this measure of all our savings.

If any reader thinks that the consumption can be measured at less than what fifty cents a day will buy at retail prices, let him try it. On that low estimate such are the facts. I am inclined to esteem the valuation of our capital too large, and the valuation of our consumption too small.

We can never beat old time more than two or three years—or, at the utmost, four years—in the richest nation, because there is nothing constant but change. There is no such thing as fixed capital. The inventor and the scientist are the great destroyers of wealth, substituting for the old mechanism the new devices by which production is increased, labor is diminished, prices are reduced, and wages are augmented. All of permanent influence that we can save is experience and skill, which, being developed in practice, assure a reduction in the necessary hours of labor, a relief from the intensity of toil, and, as time goes on, a sure removal of noxious and unwholesome conditions of work. Yet, narrow and strenuous as these conditions are, in the world there is always enough. Where is it? In this country there is always more than enough for the support of life through each period of four seasons making a year. The world has become a neighborhood. The food which each reader ate to day, the fibres in which he was clothed, and the materials with which he was sheltered, had been brought, on the average, a thousand miles or more, from the place of their origin. Yet he had only to tap a button in the wall of his house to bring his whole supply to his table or to his service at the very time and place he needed it. Such are our material wants, and such is the approximate measure of our supply.

Dealing with this question under these conditions, it becomes evident that the prime factor on which the prosperity or general welfare of the whole community rests is mental, and not manual. If there is confusion of mind in the use of words, there will be confusion in the laws. If there is confusion in the laws, there will be obstruction to mutual service. If there is confusion of mind in the conduct of affairs, there will be confusion in all the material processes of distribu-

tion; there will be a glut here, want and starvation there. Men may suffer want close to the abundance by which their wants could be met to their own benefit and to that of whoever should supply them. Idle men may crowd the cities while the materials of existence—food, fuel, clothing, and shelter—are lying at a distance of only one or two days' work. Such have been the bad conditions which have ensued since the silver panic of 1893, caused by mental aberration, and not by lack of a supply adequate to all material wants. A few years ago the price of a day's wages of a good mechanic sufficed to move his year's supply of food a thousand miles. To-day the day's wages of a common laborer at the seaboard will suffice to bring that man next-door neighbor to, or at a day's journey from, the farmer of the Mississippi valley. But, if the credit of the money in use is touched, or if the banking system is inadequate, the products cannot move.

If, then, within our great national domain there is not only enough to meet all our wants, but such an excess of food that we have in one year spare grain enough to supply the whole population of Great Britain with their daily bread, and about half the world or more with the materials for clothing, why has there been want, depression, loss, and compulsory idleness for a long period, and why have men been fearful lately that these adverse conditions might continue, or recur from time to time? In our commerce with each other as individuals we trust each other. In order that each human being in our land may find food, fuel, shelter, and clothing at his service day by day, the trade of every day amounts to at least one hundred million dollars for every day in the year; yet the losses by bad debts in this trade, in a normal year, are less than twenty-five cents on each one hundred dollars of credit granted, and, even in a panic year, not over fifty cents on each one hundred dollars. "The trust reposed in and deserved by the many makes the opportunity for the fraud of the few." The vast proportion of men intend, either from principle or from self-interest, to do right, and not to wrong their neighbors. Even the swindler must support good government, because without it there would be no opportunity for him to cheat. Where all are swindlers, there can be no fraud, because there is no trust. When a proposal is made for the government to commit fraud, every trust is vitiated.

What, then, has been the cause of our recent adversity? Why is there any doubt of an immediate return to prosperity? If the material conditions are all that can be desired, what is the mental fault which proves our present incapacity to enjoy the huge advantage in position which we hold over all other nations? Can any reply be given to this question except one? As a people, are we not painfully lacking in common sense?

The prosperity of this country will be assured when common sense is applied to the three principal questions now pending.

First and paramount. The adjustment of the monetary system of this country finally and absolutely to the unit of value which has become the standard of the world's commerce,—namely, a fixed weight of gold.

Second. The adjustment of the laws for the collection of the national revenue to three fundamental principles of taxation :

A. All taxes that the people pay the government must receive.

B. Taxes upon articles of consumption must not be imposed upon articles which enter into the processes of domestic industry. When imposed on articles of common use, they must be put only upon those which can be spared without impairing the productive power of the individual or the nation.

C. All taxes should be so imposed as to work the least interference with the freely-chosen pursuits of the people.

Third. The banking system must be readjusted to the pursuits of peace by the removal of the prohibitory tax on bank notes, so that every section may be enabled to establish its own centres of bank credit under general provisions of law that will give assurance of the redemption in gold coin of all bank notes issued.

Assuming these conditions precedent to have been attained, as they may be, slowly, but surely, the nation will then, for the first time in its history, be fully able to take its naturally paramount position in the service of nations and in the attainment of its own general welfare. For the first time in our history we shall then be enabled to work our vast resources to the general benefit. What are these vast resources ?

The resources of this country are such that, in dealing with any period of which one may rightly attempt a forecast,—say, for the twentieth century,—we may assume that our power of production is unlimited, while our power of domestic consumption is limited. The problem before us, therefore, is one of distribution rather than production. What we have to seek is a wider market for the excess of our product of nearly all the necessaries of life, to the end that, in exchange for this excess, we may import and enjoy more of the comforts and luxuries.

In order that such an exchange may be made, we must not only have the excess to sell, but must remove all possible obstructions to purchases, so that other nations may be able to send their goods to us,—for nearly all commerce consists in the exchange of goods for goods.

We will pass quickly in review, first, the material resources of the nation ;

Second, the sources of the power of other nations to purchase our excess;

Third, the relative burden upon ourselves and other nations in respect to national taxes and military forces.

True progress in human welfare consists in a continuous and steady increase in the share, or proportion, of each year's product which is distributed in the form of wages or earnings; in lessening the relative part which falls to profits, rents, and interest; and in strictly limiting that part which is taken by taxation to the necessary work of government.

Bearing in mind these fundamental ideas, we may now review our own resources in connection with the disposal of our excess of product.

First. The prime necessity of life is food. It consists of grain, vegetables, meat, fish, dairy products, and the auxiliary products of hay and grass. In these pursuits more than forty per cent. of all who are occupied for gain in this country are directly employed; if to the number listed under this title be added laborers employed a part of each year on farms, workmen occupied in milling, meat-packing, and the like, and that part of those engaged in transportation who are occupied in moving food-products by rail and water, there is no reasonable doubt that one-half the work of the nation is devoted to the production and distribution of food-material.

In 1891, which was the year of largest product and greatest return in money ever reached, the area of land devoted to the production of grain of all kinds, potatoes, hay, and tobacco numbered, in acres, a fraction under two hundred million. Leaving out tobacco, and putting in garden vegetables, the result would be about the same. That area comes to a fraction under three hundred thousand square miles. That is to say, on one-tenth of our national domain, omitting Alaska, we produce such an excess of food-material that in a recent year our export of wheat and wheat flour only, had it all been taken by the people of the United Kingdom of Great Britain and Ireland, as most of it was, would have supplied a barrel of flour to each inhabitant for that year. That is about the average consumption of wheat flour in this country,—a little less than that of Great Britain. In addition to that export of wheat, other provisions were sent abroad in very large quantity. Yet, in the production of these crops under normal conditions, such as existed from 1873 to 1892 inclusive, the wages or earnings of those who are occupied in making them were from fifty to a thousand per cent. higher than in other grain-growing countries of the world.

In 1862 the area under these same crops was a fraction under

eighty thousand square miles, and that was assiduously cultivated by hand. In thirty years—between 1862 and 1891—our population increased only one hundred per cent., but the area under the plough in grain and other food-crops increased more than two hundred and fifty per cent. The product in tons trebled. The farm value of these crops at lessening prices increased from $706,887,495 in currency—$487,045,482 in gold—to $2,283,999,656 in gold, or, on a gold basis, four hundred per cent.

Under the abnormal conditions which have prevailed since 1893, from which we are now emerging, this product was slightly diminished, but the value was reduced, by the paralysis of commerce and industry, more than seven hundred millions in 1895, as compared to the crop of 1891 almost similar in quantity. We are about to crush the men who brought on that paralysis, and we are now resuming the normal condition of supremacy in supplying ourselves and our neighbors across the seas with the chief supply of necessary food.

We have been enabled to do this work in the service of mankind by the application of science and invention to agriculture, of which there was very little prior to 1873. Setting apart the revolution in iron and glass, commonly referred to under the names of Bessemer and Siemens, but greatly developed and improved by American inventors, I can find no art listed under the head of "Manufactures" in which there has been so complete a revolution in method (by the application of modern mechanism and the science of dealing with the soil as an instrument of production rather than as a mine) as that which has occurred in agriculture. Yet, although this huge abundance and excess of production beyond our own possible consumption has been generated only from a tenth part of our land, the new methods have been as yet but half learned, and our crops as yet are but half what they will be, from the same area, as time goes on.

How much these changes mean in the household appears from a single fact which speaks volumes. I quote from a letter from the Deering Harvesting Co., which relates to the production of grain before 1873 and after.

> The advent of automatic self-binders has brought about a new order of things upon the farm, for, while in the early days the housewife had to provide for eight or nine harvest hands, she now provides for three. In the early days, when eight or nine men had to be employed, it behooved the farmer to move rapidly, and boys could not be depended upon to lay the grain for a gang of expensive men at two dollars to five dollars a day to bind and put in the shock. Now that harvesting machinery has been given intelligence, as it were, the farmer's boy lays twelve acres of grain so that a man and a boy can shock it. *The result of all this is that the farmer employs no additional help when the harvest comes.*

It needs but little imagination to conceive the relief from the

drudgery of the domestic kitchen, soon to be yet more alleviated when my own simple inventions in the preparation of food, now free of patent rights, come into common use. From these figures and facts one may comprehend why the number of farmers in the great grain-growing States increased between 1880 and 1890, while the number of farm laborers diminished.

One other element of food may be treated. The late Spencer F. Baird, fish commissioner, once told me that the quantity of fish consumed by mankind was literally in the proportion of a drop of water to a bucketful as compared to the untold abundance of the ocean. That proportion may soon be increased to two drops by the adoption of cheap methods of freezing fish as fast as they are caught and put into the hold. This process is now in use in the British fisheries, in the expectation of sending frozen fish all over the United Kingdom in a perfectly fresh and wholesome condition.

We may next deal with clothing. The area devoted to the cotton fiber in this country, compared to the whole area of the cotton country, is about as one square in a checker-board. Yet upon that little patch we provide the material for cotton clothing for the greater part of the world. If cotton factories shall be built in China and Japan, their supply of the cotton fiber must be mainly sought with us. The cotton of India and China is relatively poor and unfit. That of Egypt, which seems to be our competitor but is not, is used for the finer spinning of Europe and this country, for which there is as yet no other source.

The whole export of cotton fabrics of Europe and of this country to China would supply less than forty million out of four hundred million at five pounds a head. We consume three or four times that quantity. Yet the Chinese as a nation are clad mainly in cotton fabrics, hand-spun, and hand-woven from their very short and inferior staple. When factories shall have been constructed in China, we may exchange our cotton fiber for their silk and ramie fibers, each being benefited. The earnings of our hands in the cotton fields are five to ten fold those of the poor Chinaman or Japanese. We cannot afford to spend time on the arduous handicraft of preparing raw silk, or what is called "ribbon ramie," when we can have that arduous work done for us in exchange for our cotton by those who are sometimes called "pauper laborers." When for one day of our high-priced labor we may secure the product of five, ten, or twenty so-called "pauper laborers," we are the more benefited, yet they share in the mutual advantage.

Our supply of flax waits only for the invention of processes by

which the fiber in the straw, which is now burned, can be saved. It is now raised for the seed only, as we should long since have raised the cotton plant in the northern States for the seed only, had a plant suitable to our climate been discovered yielding seed without fiber.

Wool. As to this fiber the question arises: how shall our product be raised from insufficiency, and how shall it be saved from the bad handling which it now receives save in a few exceptional cases, making it compare so unfavorably with Australian and other clothing or worsted wool as to be almost a disgrace to our wool-growers? The value of our wool clip is about one per cent. of the total farm product. It might be readily increased in quantity and value, so as to become sufficient for our own abundant use, with an excess for export, were the wool-growers only protected by suitable legislation. Within an area of sparsely-populated territory in the middle south, comprising the "Land of the Sky," the Piedmont and Cumberland plateaus, northern Alabama, and the Blue Grass section of Tennessee and Kentucky, there is an area nearly as large as France, endowed with climate, soil, and conditions most favorable for breeding every variety of sheep, except those of the tropics, from which we derive coarse carpet wools. Every kind of food could there be supplied in greatest abundance. Sheep which had fertilized the cotton fields for the next year's crop could be carried through the winter on the refuse of the cottonseed-oil mills. There is but one thing needed to assure an excess of wool as well as of cotton, and that is protection. Not protection against Australian or South American wool-growers, but protection against the cur dogs which infest this whole area, with the possible exception of the Blue Grass region of Kentucky. The cur dog is the sign of conditions which forbid progress in all branches of agriculture in which sheep are the most important auxiliary. So long as the cur dog rules the States in which the wool-growing section most fit for abundant production is situated, we may remain dependent upon other countries for a part of our material for clothing.

We may now briefly consider shelter, the third factor in existence, — timber, stone, and brick.

We have been wasting our substance in the rapid destruction of our forests, but we may have learned in time that they must be renewed, not so much for a supply of building-material as to protect our domestic water-supplies and our sources of irrigation for arid lands. We are passing out of the period of timber construction in cities. The supply for country dwellings will always be ample. We are passing through the period of iron and steel construction, and presently we may reach a point in the upward spiral course of progress where we

shall return to the prehistoric age of clay. The Boston Public Library is one of the first and best examples of construction mainly consisting of clay tiles within walls of stone,—more nearly fire-proof than any other building of which I have knowledge. One can not doubt that the main elements of construction, after a period of veneering upon steel, will consist of brick and clay tiles. Then buildings suitable for their purposes will be entitled to long duration, free of the danger of being twisted by fire or weakened by rust; but, before that period is reached, the art of brick and clay must be developed, and the almost lost art of mortar and cement must be recovered.

Is it not, then, true that we possess the highest potential in the production of the materials necessary for existence,—food and fibers in vast excess of any wants that can be developed in the next century, with the assurance of adequate shelter of any number of people that may be reached in that period? Yet without the control of all the metals that animate the arts, with the single exception of tin, our paramount control of the commerce among nations might not have been assured.

In this, again, our only present need is to find a wider and wider market for the excess of coal, iron, steel, copper, and lead, which the resources of almost every section present. While the mines of iron and coal in other countries are becoming more and more deep and costly in their working, and while some of the main deposits of ore from which steel can be made are approaching exhaustion, our own ore banks and coal-beds are but half opened, and, by improved methods, coupled with lessening cost and increasing wages, our exports of metal work are developing by leaps and bounds. Many of the examples of metallurgy now exported are products from the sale of which the highest wages earned by any class of artisans in this or any other country are recovered.

Between January 1, 1879, when specie payment was resumed with a gold dollar as a unit, and the spring of 1893, when the shock to the national credit caused by the silver craze brought on a partial paralysis of trade, commerce, and industry, our exports had once reached the billion-dollar mark. They are now once more rapidly approaching that mark, but this time they consist more and more of the highest type of finished goods, less and less of our crude materials. Even the slight additions to the free list and the small removals of obstruction to traffic in the materials used in domestic industry secured in the existing tariff law have given an opportunity to compete with other nations which finds its expression in this steady increase of the exports of finished goods.

Let any one glance for himself over the weekly manifest of exports from New York. He will find from this record that goods and wares of every kind pass out of the harbor to every quarter of the globe. If he will look further, he will observe that in every type of exports,—whether crude, partially manufactured, or finished goods,—the wages or earnings recovered from the sale are higher in rate and, more especially, in purchasing power than in any of the countries to which these goods are sent. They are also higher than in any manufacturing country with which we compete in supplying the increasing wants of the world. If the rate of wages were the prime factor governing the cost of production, and if upon that rate rested our power of competition, not one dollar's worth of this vast quantity of goods, representing our excess of products, could be sent out in exchange for the comforts and luxuries of which our imports mainly consist.

If the points made in the foregoing statement are tenable, it follows that, by way of the highest rates of wages yet recovered from the sale of products in this or any other country, we have attained a position which gives us assurance of being able to supply the increasing wants of the world as they become more and more developed by the ocean-steamship service, by railways, and by inland waterways. These conditions making for prosperity are due to our natural endowments, the principal elements of which have been noticed.

We now turn to what may be called the potential of demand upon us for the service which we can render. Upon an analysis of our exports, the startling fact is at once brought to our attention that our best customers are those who have been regarded as our sharpest competitors. For many years the United Kingdom of Great Britain and Ireland has taken one-half our total export. The British colonies and dependencies have taken ten per cent. The manufacturing nations—Germany, France, Holland, and Belgium—have taken twenty-three per cent., leaving but seventeen per cent. to all the rest of the world. The British colonies and dependencies themselves, aside from the mother country, buy more from us year by year than all the Spanish-American States on this side of the ocean. The reason is very plain. The nations which have adopted labor-saving inventions and which have applied mechanism to production with the greatest success are those which have attained the highest power of purchasing what they want. They do not exchange goods for goods with us in even proportions, because in the competition of science and invention we can deliver almost every manufactured fabric at less cost than they can, while deriving higher wages and better conditions from the service. They pass to our credit at the gold standard the huge balance of exchange

on our merchandise traffic, against which we draw for our excess of imports over exports in our traffic with the non-manufacturing nations.

It will be remarked that the stability of our traffic with the great manufacturing States of Europe is assured by their stern adherence to the gold standard. Another element in their potential to buy from us the necessaries of life in very large measure, or the materials by which their manufactures are supported, all being more or less dependent upon us for such supplies, consists in the stability of their government, notably that of Great Britain and her colonies and dependencies. Wherever the English common law has been carried by the English-speaking people, coupled with firm administration, prosperity ensues,—better and safer conditions of life are assured. Witness the example of Egypt, where for the first time in recorded history the Egyptians are no longer despoiled. Again, during the last fifty years, wherever the English administration has been carried, the same opportunities for commerce are given to all nations that are granted to themselves. Whatever may be the variation in the duties upon imports in the English colonies and dependencies, they are uniform. The effort to colonize for the purpose of the sole control of commerce has been cast aside by the English-speaking people for half a century as a relic of ignorance and barbarism. Unfortunately for themselves as well as for others the same rule has not been adopted by the manufacturing States of Europe. Germany, France, Holland, and Belgium, although enjoying the advantages of a stable government at the present time, yet still grasp for the control of great sections of the earth heretofore unoccupied by civilized races, in order to secure to themselves an advantage in commerce over others. They have failed to do so, and will continue to fail so long as they hold to that delusion. Yet next to the demand of English-speaking people upon us comes that of these manufacturing States,—France, Germany, and the Low Countries.

One may not doubt that our power to supply the limited demand of Asia, Africa, and South America will increase with the removal of duties on crude materials or articles which enter into the processes of our own domestic industry.

The great undeveloped territory, the one great continent still open to increase of traffic, waiting for good government, a sound currency, and improved methods, is South America. Its purchasing power, even combined with other so-called Spanish-American States and islands, is very small, yet the continent of South America—of nearly twice the area of the United States, including Alaska, and occupied by a less number of people—is capable of almost unlimited development, under wholesome and healthy conditions, throughout the great

interior plain and pampas of Argentine and Bolivia and in many other parts of the continent. It is waiting for the stability which has been elsewhere assured under the English common law, and also for a stable currency, without which no nation can greatly prosper. Recent developments in Mexico give ground for hope that the lesson has been learned, and that the evil influence of the Spanish Conquest and its development of rapine and plunder may, after four hundred years, cease to bar the progress of South and Central America, of Cuba and the Spanish main.

Finally, there are a few considerations aside from our abundant resources on which we may rest the future commercial supremacy of this nation. Our tax for national purposes in actual money per head is only half, perhaps less than half, that of the most lightly taxed nation in Europe. As compared to the value of our annual product, our national taxes are less than one third of those of the most lightly taxed nation in Europe. But that advantage in money is but a trifle compared to our freedom from the blood tax and labor tax of standing armies and navies. Modern commerce turns from one side of the world to the other on the difference of a cent a bushel, a half a cent a pound, or a quarter of a cent a yard, on the great subjects of international commerce. Our national tax for all purposes does not exceed two and a half to three per cent. of the value of our annual product. It is to be doubted whether there is a nation in Europe in which the national tax does not take at least six and probably eight per cent. of the annual product, and from that, it is alleged, up to one third. This difference in money taxes only would, in a broad and general way, be more than equal to a cent a bushel, a half a cent a pound, or a quarter of a cent a yard on the great subjects of international trade. The one supreme advantage which this country possesses over other competitors is the principle of liberty, absolute free trade over a greater area and among a larger number of people than ever enjoyed that advantage before, and our freedom from the burden of a standing army or the need of any navy except such as is required for maritime police pending the time when, by a treaty even among the English-speaking people only, private property upon the sea may be exempt from seizure and privateering may be dealt with as piracy.

Were our standing army and naval force at this time equal, in proportion to our population, to that which burdens Germany and France, even including with them Great Britain, they would number nine hundred thousand men. That is almost exactly the number occupied in our railway service. The difference in our conditions and our advantage in potential in making use of huge resources may be

measured by the contrast which might ensue were we subject to the divisions of race, creed, condition, and trade animosity which now make Europe one great armed camp, waiting but the word which may be spoken by an insane ruler at any moment to generate such wars as the world has never yet witnessed. If any one can imagine the difference in the service which our nine hundred thousand men now occupied upon the railways render to humanity as compared to the burden which would be imposed upon us if nine hundred thousand of our citizens were wasting their time in camp and barracks, supported by another great body nearly equal in number, then whoever brings that condition to mind will comprehend the forces which are making for our prosperity.

The one problem still at issue, without the true solution of which all these great material resources may be wasted while want takes the place of welfare, is the single question: has the struggle through which we have lately passed so far developed common sense among the masses of the people as to enable them to compel their representatives to take the money question, the bank question, and the revenue question out from the disorder of partisan politics, in order to assure a settlement consistent with the rules by which men of common sense and sagacity are governed in the conduct of all their private affairs?

With the rendering of the verdict that the honor and integrity of the nation must be maintained and that freedom shall not perish in this land, the work of removing the restrictions with which we have retarded our own progress will only have begun. Is it not passing strange that the members of a community to whom no undertaking seems too great; who have no long-standing prejudices of caste and class to surmount; who make precedents rather than hamper themselves by them; who but a century or a little more ago reversed all historic precedents by establishing the reign of law founded on the consent of the governed; and who are in possession of resources so great that their burden is that of abundance, not of scarcity,—should yet be afraid of the very principle of individual liberty by which this nation lives and moves and has its being? The powers of legislation were granted by our forefathers to the government, in order that the right of each and every man to serve his neighbor might not be impaired. Is it not time to ask ourselves whether we have not permitted an abuse of that power of legislation? Absolute freedom of trade within our own country was so well assured by the very principle of personal liberty incorporated in the letter of the constitution that nowhere else are its benefits enjoyed over so wide an area or by so great a number of people; yet, with that assurance of freedom of domestic trade, the door was left open for sub-

tle and dangerous restrictions in the methods of distribution and for very great abuses of the power of taxation. May we not, then, take up the work which still remains for us to do, actuated by the same principle of personal liberty which, under the stress of civil war, has been so long and so much impaired? Must we not limit the functions of congress mainly to purposes of national defence and to its other very limited duties, no longer even permitting it to restrict the freedom of the individual, except so far as it may be necessary for the maintenance of the rights of others?

The nation has declared that its lawful unit of value, a dollar made of gold, shall be maintained, and that no kind of money which requires an act of legal tender to keep it in forced circulation shall be made use of, except for subsidiary purposes, and even then shall be subject to prompt redemption in gold coin.

The next duty must be to adjust the present system of banking, safe and suitable though it has been under the stress of war and even since, to the expanding conditions of trade and commerce born of peace, order, and abundance.

It will be our further duty to so adjust our system of national taxation that no man shall be restricted in his freely-chosen pursuit, whether in agriculture, manufactures, or commerce, so long as he impairs no rights of his neighbor, or only so far as it may be necessary to take from the community a small part of the general product for the support of the government. Should we not, then, choose as the subjects of national taxation only those articles which are mainly, if not wholly, of voluntary use? Shall we not spare the tax-payer from any burden by which his productive energy may be impaired, or by which the cost of the materials, tools, or mechanism with which he works may be increased? Daniel Webster once uttered the dictum that "there are many products which could be so well provided for us by the pauper laborers of other countries with whom we may exchange that we can not afford to do such work for ourselves."

It is only in recent years that the true motive and principle of commerce has been comprehended. Is it not a principle which may be stated in simple terms? Are not high wages or earnings in true money, or in what good money will buy, derived from or recovered from the sale of the products in which the cost of labor per unit of product is the lowest? Nearly a billion dollars' worth of our farm products and other goods and wares are now passing out of our harbors to every part of the world. The wages paid for the production of these and recovered by their sale have been from twenty to five hundred per cent. higher than the wages prevailing in the countries to which these goods are exported, or in the manufacturing countries with which we

compete in supplying the increasing wants of the world. Is not the cost of labor the lowest in those countries in which the natural resources are the most complete and adequate, the application of science and invention most rapid and effective, the readiness and versatility of the workmen the greatest, and the burden of national taxation the least in ratio to the product from which it is derived? What other nation or State approaches us in the enjoyment of these conditions, nurtured under the principle of personal liberty, of equal opportunities, and of equal rights? What other nation or State can emulate us in the power of mutual service by which all commerce among men is governed, after the restrictions which we have imposed upon ourselves have been removed?

The result of the election has justified the forecast recently made in these pages. Party lines have been forgotten. Right-minded men have joined to sustain the honor of the nation with the same common purpose that brought them together when its life was threatened. If those who have now been charged with the conduct of the government for the next four years prove equal to the duty which has been entrusted to them, that support will continue to the end, so that freedom may be justified and the principle of liberty may finally govern the nation. If they should fail, others will surely replace them, until the paramount position in the great commerce of the world to which this country is entitled shall have been attained. When that time comes, the reign of law, under which life, liberty, and property will be safe from harm, will have justified the principle of personal liberty by the maintenance of peace and order. The power not only to supply our own wants, but to relieve other nations from a part of the burden of war debts, taxes, armies, and navies by which their progress in the true life of nations is now retarded, even if not wholly stopped, will have been realized.

What stands in the way of attaining the true place of which I have attempted to give a dim vision? Is it anything but our humiliating fear of under-paid labor, and our lack of full confidence in the quality and character of our people?

EVIDENCES OF HEALTH THROUGHOUT THE INDUSTRIAL WORLD.

By L. G. Powers.

IN examining a candidate for life insurance, a skilled physician seeks not only visible indications of health or disease, but physiological antecedents. He strives to ascertain the facts in the man's history making for good or ill health. This knowledge is even more important than that disclosed by a physical examination. It is essentially the same in any wise study of the health of the industrial world. The conditions of society on which must rest trustworthy promise of future business prosperity and stability have their origin or foundations in the past. Prosperity grows out of the life of a nation, and bears the same relation to it that fruit bears to the tree that produces it. A tree that has regularly borne much good fruit, if green of leaf and sound of branch and body, is reasonably certain to bear similar fruit in the future, even though barren this year. In contrast, the tree which in the past has produced no fruit, or only fruit of an inferior kind, can not by its blossoming give any promise of a desirable harvest in the future. It is the same with nations and their industrial life, with its fruitage of prosperity. We must consider not only the present indications of prosperity, the blossoms, as it were, on the tree of national industry, but also the quality and quantity of the fruitage of our national tree in the past. Recognizing this fact, the writer, in the present article will first briefly call attention to the facts in our industrial history that best illustrate our economic and social condition as a people, and are therefore the best indices of the foundation of our hope for, and belief in, future prosperity.

In 1870 the property of the United States was valued by the census authorities at $30,000,000,000 in currency, or $24,000,000,000 in gold. In 1890 that property had so increased in value that it was worth $65,000,000,000 in gold. In twenty years the people of this land added to their tangible possessions property to the value of $41,000,000,000 in gold. Stated in millions of dollars, this addition to our national wealth gives but a vague indication of the prevailing and improving industrial health and strength which rendered such addition possible. To give some clearer apprehension of the subject, the writer will try to express this gain in other ways. From 1870 to 1890 the United States added to its wealth almost twice as much as it was able to accumulate from its first settlement at Jamestown to the year 1870.

It was able to add a sum greater than all the inhabitants of the American continent had been able to save from the days of Columbus to the year named. Nay, more, these $41,000,000,000, added to our national resources in the twenty years ending with 1890, represent a sum greater than all the savings of the race from the days of Adam to the first, and possibly the middle, of the eighteenth century. In other words, our nation in twenty years accomplished more in the way of housing and providing shelter for its people and giving them improved methods of production and transportation and better food and clothes than had been achieved by the race before the year 1700.

The wealth thus accumulated may be considered in still other ways. In 1870 the population of the United States was about 38,000,000, and in 1890 it was over 62,000,000. The savings of these millions for the whole twenty years were, on an average, over forty dollars per annum for every man, woman, and child in the nation. In any seven years of this period the average family saved as much as it was worth in 1850, and in sixteen years accumulated as much as it possessed in 1870,—the beginning of this period.

But more important in this connection than any of the facts given above are those showing the distribution of these vast accumulations of recently-acquired riches. The census of 1850 estimated the number of real-estate owners in the United States in that year as 1,500,000. Therefore, at that time, according to the census, 6.47 per cent. of the population and 35.95 per cent. of the families in the country were possessed of real estate, either free or encumbered with debt. The census of 1890 reports 6,066,417 families living in houses or upon farms owned by themselves. Of this number 4,369,527 owned their farms and homes, free from all mortgage encumbrance. In addition, there were many other owners of real estate, besides these owners of houses and farms used as homes. The owners of homes free from debt made up 6.98 per cent. of our population and 34.93 per cent. of our families in 1890. In other words, there were relatively as many people owning homes free from debt in 1890 as there were owning all kinds of real estate in 1850. The people owning both free and encumbered homes in 1890 constituted 47.90 per cent. of the families and 9.69 per cent. of the population. Taking the family as the unit, we find that the ownership of property in 1890 was 33 per cent. more widely, and hence more equitably, distributed than in 1850. Taking the individual as the unit, the improvement is equal to fifty per cent. This progress may be shown in another way. In 1850, of the families of the toilers upon our American farms 20 per cent. were slaves, and not less than 27 and possibly 32 per cent. more were laborers for wages, or tenants. Not more than 53, and possibly not more than 48, per

cent. of the families residing upon and obtaining their living by tilling the soil were owners of the land they cultivated. In 1890 at least 63 per cent. of such farm families owned the land tilled by them, and less than 37 per cent. of the heads of families toiling upon farms were tenants or laborers. The relative proportion of farm tenants had doubtless somewhat increased in forty years, but that of slaves had vanished, and that of laborers had greatly decreased. The relative increase in the proportion of farm owners was greater, however, than that of farm tenants, and the percentage of heads of families toiling on the farms as laborers was but little more than one-half that of either free or slave laborers in 1850 or 1860. All these facts are indications that show how the tree of our national life has increased its fruitage,—the prosperity of the masses of our people. The facts cited show that, whatever may be our present transient indications of prosperity, we have in them from 33 to 50 per cent. more ground for expecting such prosperity than had our fathers in 1850.

The accumulation of wealth and the improving equity of its distribution have been rendered possible only by the further fact of the regular and continuous employment at remunerative wages of a greater proportion of our citizens than ever found work in any other nation on the globe. In 1890, of the men and women over ten years of age working at some remunerative occupation, 84.5 per cent. according to the United States Census had regular and continuous employment for the whole of the year ending May 31. The other 15.5 per cent. were employed, on an average, two-thirds of the time. The unemployed for the year averaged, therefore, only 5.01 per cent. of the total number engaged in gainful occupation The average worker was, therefore, employed 95 per cent. of the time, and was idle 18 days out of the 313 working days of the year. The same fact may be stated by saying that, on an average, 5 per cent. o. the people were in 1890 continuously idle, and 95 per cent. continuously employed. This showing for 1890, presented by the United States census, was materially better than that found by the Massachusetts census for 1885. The 95 per cent. that in 1890 were, on an average, employed all the time received wages that, in gold, were materially greater than those paid in 1870. In fact, from 1870 to 1893 wages, measured by the gold standard, had more or less regularly risen, and, owing to the falling price of the great mass of articles manufactured by machinery, the purchasing power of those wages increased to a still greater extent. In 1891 a week's wages in the United States would buy 40 per cent. more than in 1873. The saving and spending power of the masses was improved to that extent. This increase in the saving power explains the unprecedented accumu-

lation of riches to which attention has already been called. The increase in spending power enabled the masses to purchase an ever-increasing abundance of the many articles of utility and luxury. The purchase of books, papers, good clothes, good food, articles of ornament, watches, and musical instruments increased several fold faster than population. These facts, together with those before alluded to, are the best possible evidences of health and vigor in the economic and social life of the nation. They mark the existence of the essentials of a wonderful prosperity, which we, as a nation, need only to give half a chance to develop.

As a healthy man may be seized with a most violent attack of sickness, or as the best bearing of trees may have its fruit destroyed in any given year by a chilling frost, so the general prosperity of our nation was checked by the panic of 1893. That panic began with a lessened market, and thus a smaller commercial demand for the great staples of the farm and the shop. This change in demand directly led to lower prices and restricted incomes for the producers and dealers. It also indirectly lessened the opportunities of the wage-earners. Vast numbers of the latter were thrown out of work, and the average wages of the toilers were lessened. The number of the unemployed and irregularly employed became, in all probability, double, and possibly three times, that of 1890. This gave for the winter of 1894 at least seven and possibly ten million men, women, and children with more or less irregular employment, and a total average number of workers idle all the time equal to, if not in excess of, one in ten, and possibly one in eight, of all those desirous of pursuing gainful occupations. The wages received by the toilers, as a whole, were decreased over one-third from the grand total of 1890. Capital suffered with labor. The incomes of the moneyed classes were lessened, and financial ill health, or depression, as we call it, presented its symptoms on every hand. Now comes the critical question of this paper. How far has the nation rallied from that attack of 1893, and what are the indications of such a revival of business as will promise us the old-time prosperity in our land, the renewed fruitfulness of the tree of our industrial life?

In January or February, 1894, the number of unemployed or irregularly employed was very great. Since that time there has been an irregular improvement. The summer of 1896 saw the percentage of idle and irregularly-employed workers not more than three-fourths of what it was in the winter of 1894, or about one and a half to two times as great as the average for 1890. Uncle Sam had passed the critical stage of his financial attack, and was on the high road to speedy recovery. The nation gave indications of a steady gain, the

beginning of a new era of prosperity, provided only it could be kept free from the disturbance of financial quacks with their poison of free silver and its *sequelae* of commercial distrust and stagnation. This, at least, was the diagnosis of the case made last autumn by the advocates of commercial honesty and sound money. Those advocates declared their belief that revival of business waited for only one essential requisite,—namely, an end of uncertainty by the victory of sound money at the polls. The two weeks next succeeding the election, according to the reports of the daily papers in the United States, saw the reopening of 284 mills, employing a total of 164,635 men. Granting, if it is claimed, that one-third or one-half even of this army of toilers were given work by the opening of factories that run only in the winter, there are left from eighty-five to one hundred thousand operatives who returned to the ranks of industry in two weeks after Uncle Sam found security against the threatened poison of free silver. That army of men set to work since election is not less than five, and possibly exceeds ten, per cent. of the number of idle in 1896 that would have been regularly employed in the best year for labor that this or any other country ever witnessed. Multiply by ten or twenty the chances for labor that have opened since November 3, and we return to the industrial health of the strongest nation on the globe in its most prosperous year. Is it difficult to believe that this country can, in the next twelve or twenty-four months, find ways of setting this extra number of men at work? Let us see.

For example, the opening of as many miles of new railroads as were constructed in 1890 would, in grading, rail-making, and rail-laying, and in the construction of needed cars and locomotives, open to labor one-third the opportunities for toil required to set this army of idle men at work. Other writers in this number discuss the probabilities of expansion and development in railroad and other great engineering and business enterprises, that will thus transfer this army from the ranks of the idle to those of the toilers. In this connection the writer wishes to call attention to the narrow margin which at present separates us from the greatest era of prosperity that this or any other nation ever saw.

The needed employment of labor in constructing new railroads or in other enterprises of widely different character will hinge upon the profitable return for human labor on the farm and in the work-shop. What, then, is the outlook for labor in these two great domains?

As he scans the signs of the times, the writer finds a favorable outlook in both.

Turning to the monthly summary of the commerce of the United States for September, 1896, it is to be noted that the value of the

products of agriculture exported for the nine months ending with September, 1896, had a value of $416,364,411. This is $60,386,505, or nearly 17 per cent., greater than for the corresponding nine months of the preceding year. To gain a clear idea of the promise of agricultural prosperity involved in this fact, a few words are necessary concerning the cause and extent of the agricultural prosperity that prevailed from 1879 to 1882 in this country. *The years named saw a greater actual and relative return for their labor to the tillers of the soil in the United States, as a whole, than was ever realized by such workers in this or any other country.* The annual income of the farmers of the nation was in those years at least $400,000,000 greater than it averaged for the fifteen years that preceded, or the thirteen years that followed. But that period of phenomenal farm prosperity was immediately preceded by one of low farm prices and reduced farm incomes that was more severe, on an average, than the one experienced since 1893. The change from the period of low farm prices to one of higher began in 1879 by an increase in our exports of agricultural products similar to the one noted above for the last nine months. It began with an advance of farm prices due to this increased export, caused largely in the earlier case, as in the latter, by crop failure in other quarters of the globe. The trustworthiness of the promise of better times involved in our recent advance in the prices of agricultural staples may be seen by noting the following facts, showing its extent when compared with the corresponding advance that heralded the most phenomenal era that began during the season of 1879.

Wheat, as is well known, is the great staple of agricultural export raised in the north and west. The advance in its selling price in the last six months has been neatly as great as that witnessed in the corresponding six months of 1879. Cotton, the second great staple of agricultural export, the leading staple of the south, has likewise advanced in price in the last two years more than it did in the corresponding period at the beginning of the four years of wonderful prosperity mentioned. These facts, taken in connection with the crop and industrial conditions in other lands, indicate the beginning of an era of farm prosperity even greater than the one experienced from 1879 to 1882.

The figures showing the increasing exportation of live stock and live-stock products lead to the same conclusion. One great factor in the advance of prices of farm products that occurred in 1879 was the increased demand in Europe for American cattle, and their primary and secondary products, usually classified under the general name of provisions. The total value of the exports of animals and provisions for the year ending June 30, 1879, was $128,346,404; for 1880,

$142,925,362. The increase from 1879 to 1880 was $14,578,958. The corresponding total for the nine months ending September 30, 1895, was $120,840,875; for the nine months ending September 30, 1896, $132,246,924. Here is a gain of $11,406,049 for nine months. A like gain for the year will make over fifteen millions of dollars, or more than was realized in the first year of exportation at the beginning of the era of wonderful farm prosperity,—1879 to 1882.

Since the increased foreign demand for the products of the American farm began to be felt last summer, prices of wheat, oats, hay, beef, cotton, pork, steers, hogs, and most other staples of the farm have advanced in selling value. It is true that we have not yet reached that ideal of the farmer,—dollar wheat. Neither have we reached the earlier limit of maximum prices. We have, however, in all, as in the case of wheat and cotton, witnessed *as great an advance in price as was realized by the farmers in the corresponding period at the close of the financial depression, 1874 to 1878, and the beginning of the era of extraordinary prosperity that followed it.*

In another way can be shown the extent of our progress towards agricultural prosperity, and incidentally towards general prosperity,—for general prosperity always results from farm prosperity. Wheat prices have advanced so that, at the writing of this article (December 1), the selling value of wheat in Minneapolis is greater than the simple average gold price realized by the farmers of Minnesota, Wisconsin, Missouri, Kansas, Nebraska, Iowa, Ohio, Indiana, Illinois, and Michigan from 1860 to date. In the same way the prices of beef cattle, which were extremely low for the greater share of the year last past, have advanced, until in Chicago they are now nearly equal to the average for the last twenty years, and are in excess of the average in gold for the fifteen years preceding 1878.

This question of possible prosperity or adversity in store for us as a nation is of so great importance that it is worth our while to look at it in still other ways. It has been asserted by many that the prices of all agricultural staples have fallen since 1873. Some prices have fallen, but others have not. Some have fallen in one section, but advanced in others. Taking the average of all the great staples of the farm,—corn, oats, wheat, rye, barley, buckwheat, hay, potatoes, and tobacco,—and the livestock,—horses, mules, cows, oxen, sheep, and swine,—in the ten central Mississippi valley States already named, there has been no general fall of prices since 1860. On the contrary, there was a positive, though irregular, advance down to 1893. Since that year there has been a decline, but one that leaves prices, on the average, as high as in other periods of exceptional financial depression. Taking the price of 1873 as the basis of comparison and calling it 100,

the Minnesota bureau of labor found the average price of those nine crops and six animals to have been as follows, by periods of seven years: 1862-66, 91; 1867-73, 108; 1874-80, 100; 1881-87, 116; 1888-94, 103. Thus the price in the last of these seven-year periods averaged 3 per cent. greater than in the seven years from 1874 to 1880, and over 12 per cent. greater than for the war period,—1862 to 1866. They were below the prices of the periods of exceptional farm prosperity already referred to in this article. The general trend of upward prices from 1862 to 1894 was interrupted by the panic of 1893, which lowered prices for that and subsequent years. The average for 1895 is expressed by the index number 84, or about 19 per cent. less than the average of the seven years ending with 1894. The advance of farm prices already noted carries the average back nearly, if not quite, half the way to the average of the seven years ending with 1894; above the average of the war period, 1862 to 1866; and nearly up to that of the years 1875 to 1878. Who can contemplate such facts as these, and not see in them abundant and trustworthy promises of a return to great national prosperity?

But, while farm prosperity always causes general prosperity, its indices are not the only evidence of returning industrial health and strength. We can find the same in the records of manufacturing enterprise. In the nine months ending with September 30, 1896, the value of the domestic manufactures exported to foreign countries was $184,792,443, while, for the corresponding nine months one year before, it was only $145,793,834. Here is an increase of $38,998,609, or more than 21 per cent. This is a larger relative increase than that experienced in agriculture, and a far greater increase than that achieved in manufacture during the first nine months of the prosperity that began in 1879. The mine products exported increased in the same nine months from $14,246,029 to $15,703,835; those of the forest from $23,375,317 to $27,417,136. Our exports of silver, of which we have an excess, increased from $38,664,610 to $46,441,041, while our exports of gold, which we desire to use as money, decreased from $73,190,282 to $55,570,421, and our imports of the same increased from $28,839,939 to $64,888,856.

Some of these indications of prosperity are but blossomings on the tree of our national industry. They are, if not fruit, the blossoms of a tree that has always been very fruitful, and that now shows great vigor in putting out these evidences of renewed life. Will they not yield an early and abundant industrial harvest, if only we keep that tree watered with the elements of business confidence and free from the blight of financial uncertainty that has so lessened its fruitfulness since 1893?

PUBLIC CREDIT AS RELATED TO ENGINEERING ENTERPRISE.

By Gustav Lindenthal.

THOSE who remember the severe business depression from 1873 to 1879, and the revival of business prosperity in the autumn of 1879, which thereafter continued almost uninterruptedly for twelve years, will have observed that the revival was manifested in the construction of large engineering works. While in the six years from 1873 to 1879 there were built 11,499 miles of new railroads, in the following six years (1879 to 1885) 46,594 miles were built, or four times as many, and from 1886 to 1892 were built again 47,434 miles.

The expenditure of five billion dollars in twelve years for railroad construction alone, in addition to other engineering construction on a large scale, gave an impetus to every form of industrial production, which would have remained unabated but for bad financial legislation, beginning six years ago, and the consequent weakening of public and private credit.

Some of the newly-built railroads and other new improvements were, no doubt, ahead of the normal growth of the country, and not always good investments; but it cannot be denied that they largely accelerated it, contributed to quicker settlement and development, and added enormously to the general wealth of the nation. It was rather a business than an engineering problem to nurse the properties along until they should become fully self-sustaining, and thereafter very profitable.

Later, in 1888, commenced the development of the electrical railroads in all the larger cities and their vicinities, which, with the affiliated manufacturing interests, required the additional outlay of very vast sums (estimated at $1,200,000,000) for construction purposes, and for establishment of the new electrical industries. In 1893 came the depression which has lasted up to the present time.

A review of the causes which brought about the revival of prosperity in 1879–80 may enable us to judge whether a revival from the present stagnation is likely to occur soon. First among the causes was the fact that, irrespective of the industrial and commercial depression during the six years preceding 1879, the government had a sufficient revenue, not only for its ordinary expenses, but also for reducing the large public debt, incurred in the civil war. Next, the bad effects of the previous over-speculation had disappeared, and people were beginning to econo-

mize and save. No one was counting any longer on a boom, but nearly everybody had settled patiently to the conviction that an improvement could come about only gradually. Bad debts had been adjusted, living expenses curtailed, and the conviction arrived at that hard work alone could gain a living and a competency.

All these circumstances contributed to restore and strengthen business confidence almost imperceptibly, and when, from necessity, and afterwards from speculation, a large expansion of building operations, and of every business connected with them, took place, it was the progress and growth of a healthy body.

Had the first causes continued to operate; had the government continued to redeem out of revenue its indebtedness in the form of bonds, and afterwards that in the form of greenbacks; and had it continued to be economical in its expenditures, as it was until 1890,—no panic would have occurred in 1893. But a contrary policy was set up. Simultaneous with the incurrence of a large new indebtedness (for entirely useless silver purchases) was a very large increase in government expenditures, without a corresponding increase in revenues. The increase in war pensions alone, for the four years since 1890, amounted to $280,000,000, and of itself was enough to cause the recurring deficit since that time. Other items of the government expenditures were also increased, but in lesser degree. The unwise policy and profligacy of the government could not fail to shake the faith of the entire business world in its solvency and honesty. In 1893 the first symptoms of distrust appeared; a remedy was applied under great public pressure in the repeal by congress of the silver-purchase laws; but no serious attempt was made, or has since been made, to prevent a deficit. Complete recovery of public credit did not come, and the business depression continued. The government protected itself temporarily by the sale of bonds. The distrust continued, and assumed an acute form during the last presidential campaign, owing to the threatening danger of free silver coinage. The result of the election just held indicates the overwhelming desire of the people for a policy in the interest of social order, honesty, and good faith.

But the election itself is not the solution. This must now come through proper laws curtailing expenditures, increasing revenue, and affording better banking facilities. While we have reason to hope for an improvement of our public credit, with which the private credit of the business world is so closely connected, it is still essential that congress shall pass the requisite remedial laws.

It is an acknowledged fact that, in in all countries having a high public credit, private capital for large undertakings is plentiful; public and business credit are indissolubly connected. Thus, for credit

to become high and business confidence firm, the government must set the example of a well-ordered financial policy, making the outgo fit the income. With the clearing up in the public household should go hand-in-hand the clearing up in the households of business, as from 1873 to 1879. Prudence and economy are needful, therefore, not only in our government expenditures, but also in our business affairs, that we may effect a complete recovery from the unhealthy condition of the last six years.

A revival of business prosperity will assuredly again manifest itself in the construction of large engineering and income-producing works. We have to distinguish between public works for which the capital is provided from taxation—as, for instance, all harbor and river improvements, city improvements generally, and canals and bridges built at public expense—and public works built with and owned by private capital for purposes of investment.

Included in these latter are our entire railroad system, the largest in the world, and larger than that of the whole European continent; our electric power and light plants; elevated, cable, and electrical railroads; gas works; and a thousand and one other public works,—the whole representing an investment estimated at $14,000,000,000, a sum many times greater than the sums obtained for public works from taxation. It is, therefore, of the first importance for the progress of our country that private capital should be had readily and cheaply. It can provide and manage many public improvements better, more cheaply, and more quickly than can our in many ways crude public administration working with public funds.

When business confidence is unshaken and public credit unquestioned, experience teaches us that private capital is eager for investment. Interest is low, and consumption is large. The money paid out in the construction of new improvements finds its way into the channels of trade, and, being turned over and over again, begets more frequent profits and larger savings, which constitute new capital ready for investment in additional improvements. Thus, if the development of our country, with its great and unparalleled natural resources, could take place steadily and without interference from financial mislegislation, it could not fail to grow immensely wealthy. All the foreign borrowed capital, estimated at over $4,000,000,000, would be gradually repaid, leaving the nation free from obligations, private or public, to any capitalists but its own. We could keep the interest at home, as the rich European creditor nations do. We should aim to attain the greatest prosperity and the largest measure of political and industrial independence by wise economy and saving, and not by the political nostrums of permanent protective tariffs and fiat money.

Be it remembered, as an instance and illustration, that Germany, in the beginning of its modern industrial improvement and before the railroad era, was a comparatively poor country, with only the small resources of an agricultural nation. It had not, at the end of the Napoleonic wars, the population or the wealth even that it had at the end of the sixteenth century, when it was the richest country in Europe, when it had the largest and most highly developed manufactures, the most extensive continental commerce, and the greatest banking houses, and when the greater part of the gold and silver wealth of newly-discovered America had found its way through the spendthrift Spanish channels into the strong chests of its thrifty and industrious burghers and merchants. The incessant wars and devastation, beginning with the Thirty Years' War, and lasting well into this century, reduced the population, and led the country to a state of poverty, from which it began to emerge only sixty years ago. In the beginning of the seventies, Germany was yet deep in debt to other nations. A large part of the government debts, and of its railroads, water and gas works, and other like remunerative investments, were owned by foreign capital,—mostly English, Dutch, and French. Twenty-five years of uninterrupted peace enabled it not only to repay all the foreign capital it had borrowed, but to accumulate more than enough for internal improvements, some on a vast and unparalleled scale, and its banks and capitalists have made large investments—not always profitable—in Australia, Africa, South America, and the United States. No foreign capital can find investment in Germany any longer. If all this was accomplished by a nation maintaining a large standing army, what could not be accomplished by the United States, infinitely richer in resources, if its natural development were not artificially interfered with by ignorant legislation and agitation. Not only would the United States likewise be able to pay back in less than twenty-five years all the vast sums of capital borrowed abroad, but it would gradually and surely change from the largest debtor nation, which it now is, to the wealthiest creditor nation of the world, and thus become the most influential promoter of civilization in its highest sense, the most powerful republic and agency standing for peace.

Foremost among the men who can and do greatly aid in the development of the nation's wealth are the engineers. They are habituated to the responsibility of the expenditure of large amounts of money in the execution of costly works. Their training is such that economy, careful attention to details, and the application of the laws of causation to the affairs of life, become a second nature with them. Whenever their independent judgment has been called in to direct the business management of any undertakings or of public

works, it has always had beneficial results. The railroad and manufacturing corporations that have followed that policy are among the most prosperous. On the largest and probably the richest railroad in the United States, almost all the general officers, including the president, are trained engineers, who have grown up with the property. It is as yet the only railroad with a systematically-managed sinking fund for the gradual extinguishment of its mortgage debt.

The engineer is preëminently the great economizer in all branches of material wealth. It is the engineer's work that has enabled one man to produce food for two hundred and fifty persons, whereas forty years ago he could produce for only thirty persons. It was his work that brought down, by systematic economies in construction, maintenance, and operation, the average cost per ton-mile from 2 cents to 0.2 cents; the price of steel rails from $160 per ton to $21; the price of locomotives from $13,000 to $5,000; the cost of earth-excavation from 50 cents per cubic yard to 10 cents; the cost of dredging from $1 to 12 cents; the cost of bridge construction from 8 cents a pound to 3 cents; and so on, throughout every branch of engineering. Not all the taxing powers of the richest government could produce the sums which are being yearly saved by engineering science.

Although it must be expected that railroad-building in the United States will not be much longer a measure of prosperity, as the country will soon have about all the railroads it needs, there are other fields of engineering work, which have only just been approached, and where great profits are awaiting the investor.

There is, for instance, the greatly-felt need of cheap railroad-feeders. The want is in a fair way to be supplied by electrical traction roads, not only for passengers, but also for mail, express, and freight. These must be built with private capital.

A very large field for the economizing methods of the engineer will be found in the construction of good country roads, the demand for which has become stronger of late years, because of the greater number of wheelmen using them. These must be built with public funds. The demand will become irresistible with the evolution of the horseless carriage and wagon. It cannot be gainsaid that the United States, of all civilized countries, have as yet the poorest wagon-roads. Our greatest obstacles in getting better ones are not want of money so much as the too frequently ignorant and wasteful political management of public funds and properties. Fine roads can be built and maintained only under a thorough and permanent engineering organization and supervision, which should cover the entire United States.*

* Throughout Europe the labor of convicts is used for this work, in which it does not come into competition with free skilled labor.

The oldest organization of the kind (dating from 1671) is that of France, and from it the public road departments in all countries have been more or less copied. If all the money at present wasted, by unskilful and haphazard methods, on road-building and repairing, were used, together with convict labor, under the direction of such a department, the country from one end to the other would be provided in twenty years with as fine roads as any in Europe,—a great addition to the national wealth, begetting private wealth simply as a result of wise economy in the expenditure of public money.

The most important center of engineering activity with a revival of business prosperity will be New York and vicinity. The large works planned and pressingly needed are almost all for the purpose of increasing the convenience of local transportation and lowering its cost.

First to be commenced will be the new East river bridge, with about twice the capacity of the existing Brooklyn bridge. It is intended for the local traffic between New York and Long Island. So great was the recent financial depression that the cities of New York and Brooklyn, which enjoy the highest financial credit, could not obtain the money for this and other public works before the last election. But, immediately after the election, business confidence was sufficiently restored to enable them to sell their bonds at a premium, and the work may now be pushed with vigor.

Another costly bridge over the East river, but to be built with private capital, is the big railroad bridge across Blackwell's Island. The contracts for the foundations and iron work have been made. Its cost will be more than $10,000,000.

But the largest work of all, and the largest single structure ever built in the history of mankind, will be the gigantic bridge over the North river, contemplating a single span of 3,100 feet over its entire width, and which, with all the accessories of land and approaches, will cost $40,000,000. It will carry eight railroad tracks, besides roads for bicycles and promenade, and will afford entrance into New York for thirteen railroads. Hoboken, Jersey City, and the populous country in New Jersey back of them, will be connected with the business district in New York, centering around Twenty-third street. The engineering difficulties, which at first seemed to be insurmountable, are now considered less serious than the legal and financial difficulties. A large undertaking like this, likely to interfere with the valuable property interests of many persons, must unavoidably pass through a long process of litigation to establish its legal rights. The location at Twenty-third street has been secured only after a litigation of four years, finally decided by the supreme court of the United States favor-

ably to the company. The great labor of organizing and preparing the necessary broad financial foundation can be successful only after the legal status of the work has been proven sound and unassailable. Capitalists then invest with confidence, and, with the return of normal business conditions, the funds can be readily obtained. More particularly foreign bankers, who must necessarily be consulted, would not make engagements for furnishing capital otherwise. They certainly do not do so during a time when their clients are selling American holdings right and left, as they did during the recent panic. All this will, of course, change, and is changing, with a return of business confidence. The undertaking is fully prepared, and merely awaiting returning confidence.

Another bridge over the Hudson river is contemplated at Fifty-ninth street. It has designedly attracted much public attention, but as yet has not gone through the necessary legal contention. By reason of its location too far north, away from the established principal lines of traffic, this project may obviously be regarded as a work possible only at a much later time.

A valuable improvement, of local importance, will be the completion of the tunnel under the Hudson river. It was commenced more than twenty years ago, and is half finished, but had to contend with many engineering and financial difficulties. Foreign capital is engaged also for this undertaking, awaiting merely better times. The tunnel is to be used only for local traffic, on two tracks, with electric cars from shore to shore, access to it being had by means of shafts.

Another important tunnel project, work on which will shortly be commenced with complete engineering and legal preparation, is the one for rapid transit with electrical power from the lower part of Jersey City, at Exchange Place, to Cortlandt Street in New York, and thence under the city and under the East River to Atlantic Avenue in Brooklyn. Its cost will be $25,000,000. The relief it will furnish to the dangerously congested passenger traffic, particularly to Brooklyn, cannot come too soon.

The most pressing improvement in New York itself, which, it is hoped, will be now soon realized, are the so-long-debated rapid-transit routes to the northern part of the city. After long delays, expensive plans were prepared, but the courts prevented their execution, on account of their great and uncertain cost. Had private capital been intelligently encouraged to solve the question under proper safeguards to investors, rapid transit would probably be in operation by this time without any expense to the city, on the same plans which were accepted as the most practical and economical for London,—namely, on the deep-tunnel plan of Engineer Greathead. His system was pro-

posed for New York by capitalists ready to build it. But the offer seems to have been undeservedly ignored.

The capital, which thus will be put into circulation by the construction of the new engineering works for New York City alone, will reach $140,000,000.

Among the proposed great improvements near New York, and depending upon private capital, are the new terminal station in Boston and the elimination of railroad grade-crossings in Bridgeport, Conn., Newark, N. J., Jersey City, Philadelphia, and other important cities, involving a total expenditure of $90,000,000 (estimated).

Beside the large amount of railroad work awaiting construction throughout the United States, there is canal work on a large scale, the need of which is becoming very pressing. The deepening of the Erie canal has already begun. The funds for it—$9,000,000—are provided by the State of New York. For the construction of deep-water canals between Lake Erie and Lake Ontario and between Lake Ontario and the Hudson river, and of the Cape Cod canal, private capital will be employed to the extent of about $200,000,000.

The largest canal work now under way is the half-finished Chicago drainage canal, to connect Lake Michigan, through the Illinois river, with the Mississippi and the ocean. It is designed to meet the double purpose of providing drainage for the growing city of Chicago and making it the largest port for inland navigation. Its cost of $30,000,000 is borne entirely by the city of Chicago.

The list of important engineering works in the United States for traction roads, irrigation systems, aqueducts, hydraulic and electric power plants, bridges, shipping docks, tunnels, water and filter reservoirs, etc., etc., awaiting construction and better times could be prolonged for many pages. Taking only those enterprises far enough progressed for immediate construction, they will require the expenditure of $900,000,000 of private capital to begin with, which is nearly double the amount expended on railroad and other engineering construction for any one previous year of the most active era. But suffice it to say that, the beginning once made, the business activity will be greater than it ever was before,—far exceeding that of the prosperous period which began in 1879-80. Since then, the population of the country has nearly doubled, and its wealth has quadrupled. Capital is waiting to come forward, and there is no end of opportunity for its profitable investment.

But public credit and public confidence cannot reach the highest standard, unless there is unquestioned security of property.

When, during a visit to London last winter, I had a conversation with the late James H. Greathead, chief engineer of the new under-

ground railroad in London (crossing under the Thames from the Waterloo station to the Liverpool Street station), I inquired of him whether his company had much trouble in raising capital for their undertaking, and what interest they were paying.

His answer was: "After we had obtained our legislation from parliament, we had no trouble in getting all the required capital at three per cent."

"Do you mean to say you are paying only three per cent. on the cash received? That would hardly be half enough in the United States for a public undertaking with private capital."

Mr. Greathead answered: "That is all we are paying over here. The investors are satisfied to get that, and expect more only when we earn it. We can get money here at a low rate of interest, because our parliament protects property. Can you say the same thing of your congress and your legislatures? You cannot expect to get money as cheap as we can."

It was a significant comment, and by no means an isolated one. The impression unfortunately prevails abroad more than it should that property and investments are not secure in the United States in the same degree that they are in England, or in the civilized parts of the European continent, against attacks from ill-considered or vicious legislation. The relief with which the adjournment of the legislature or of congress is usually received is not unjustified.

It is more than questionable whether, in any other civilized country, a wholesale confiscation of property, and the overturning of social order itself, could have been proposed in the barefaced manner in which it was during the last presidential election. And the one not unfounded fear is that these attacks may be repeated in the future, merely changing their form from the silver and riot issues to some other issue of equally baneful influence upon business morality and upon the security of property.

PROGRESS AND PROMISE IN AMERICAN SHIP-BUILDING.

By Lewis Nixon.

IN discussing the progress of ship-building, I shall confine my observations to the steam marine; not because no advancement has been made in construction of sailing vessels, but because almost the whole volume of popular interests centers on steam and the development of the steamship.

To avoid tedious and irrelevant detail I will date the era of the modern metal-built steamship in this country from the laying of the keel of the George W. Clyde—about 1869.

Some other coasting steamships were built in that and the two succeeding years, and in 1872 the Cramps entered the transatlantic field with the four ships of the original American Line,—the Ohio, Indiana, Illinois, and Pennsylvania.

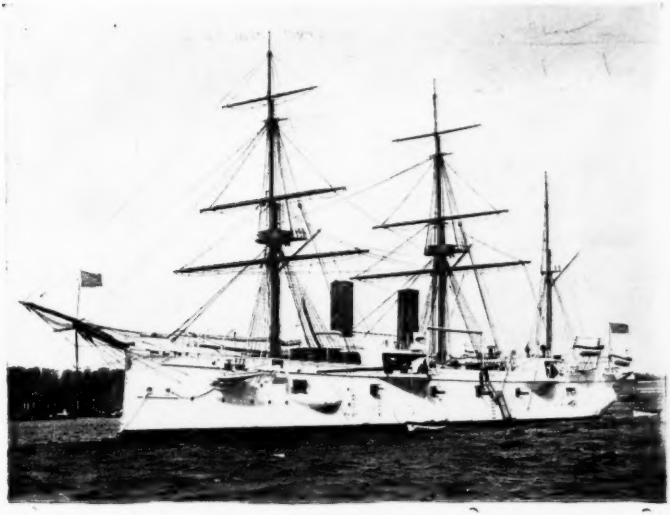
Roach soon followed with various products of the Chester shipyard for the Pacific Mail, Brazil, and other lines, and Harlan & Hollingsworth of Wilmington struck and held the pace of a good second to their larger neighbors.

But, ably and promisingly as this new era was ushered in, its progress did not sustain the promise of its inception. Good ships were built, and the American practice in yard or shop did not lag behind that of English builders. The market for their wares, however, did not rise with the development of facilities. The government, which in one way or another must always foster any successful ship-building industry in this or any other country, remained supine during the early years of the new era. And, while our government was thus neglectful, every resource of the British government was applied, and every inducement offered, to promote the progress of ship-building in England.

These conditions prevailed all through the seventies and the first half of the eighties, until the government, resolving to have a new navy, appeared in the market as a customer.

Fortunately, during this dreary period of twelve or fifteen years of inanition, the *materiel* of our coasting traffic found need of renewal or increase, and the demand incident to this fact proved just about sufficient to nurse the spark of life in American ship-building.

Meantime English ship-building was progressing by leaps and bounds,—gaining almost absolute control of the North Atlantic, because, no matter where owned or under what flag sailed, almost all



U. S. CRUISER CHICAGO, 4500 TONS DISPLACEMENT.

Length 325 ft., beam 48, draft 19. Built by Jno. Roach, Chester, Pa.

Copyright 1891, J. S. Johnston, N. Y.

ships in North Atlantic lines during this period were built in England. Subsidies were showered on English steamship lines, and English ship-yards and machine shops were glutted with contracts for construction of hulls and engines for the British navy.

About all that American statesmen attempted for American ship-building during this fitful epoch was the introduction of free ship bills in congress! No matter what theories prompted this proposed policy, its practical result would have been the employment of American resources to aid the English government in its efforts to promote English ship-building.

In 1883 the government began its new navy with the Chicago, Boston, Atlanta, and Dolphin. These were the first steel ships. As soon as their construction was attempted, the result of twelve years' neglect became apparent. Nobody knew whether this country could produce the necessary material or not, but the three leading ship-yards of the east submitted bids. Roach got the awards, but the sequel proved that he had discounted the unknown chances too heavily. The vessels, however, while not proving a source of profit, established a high standard for future construction, and are to-day useful and serviceable on the active list of the navy.

U. S. S. MIANTONOMOH, 3990 TONS DISPLACEMENT.
Length 259.6 ft., beam 55.10, draft 14.6. Built by Jno. Roach, Chester, Pa.
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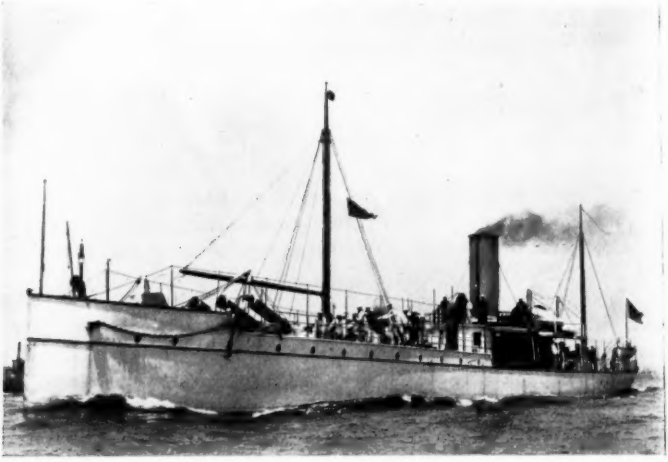

U. S. DYNAMITE CRUISER VESUVIUS, 930 TONS DISPLACEMENT.
Length 251 9 ft., beam 26.5, draft 10.7. Built by Wm. Cramp & Sons, Phila., Pa.
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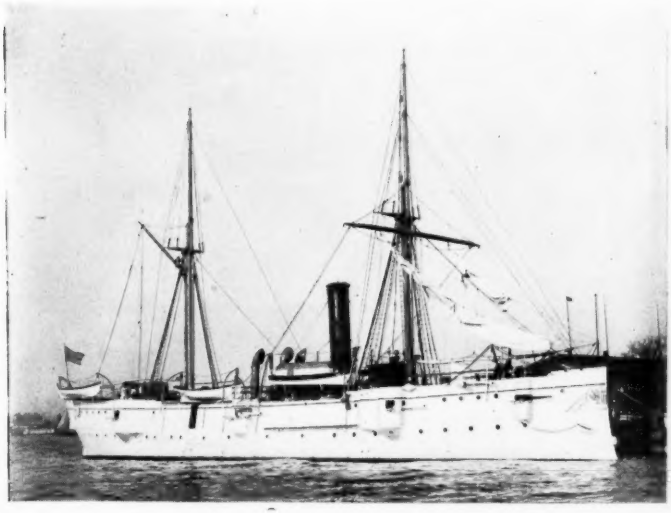


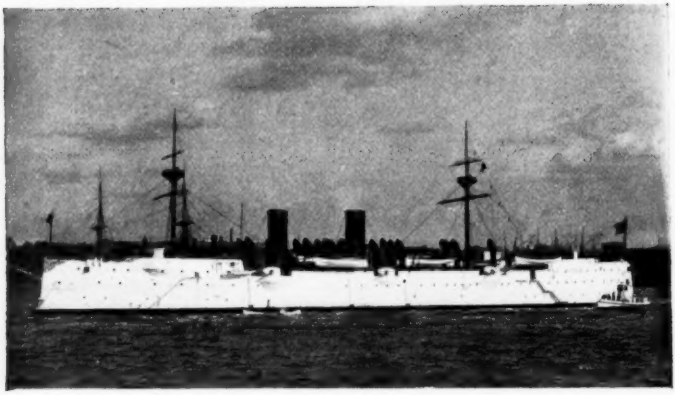
U. S. GUNBOAT MACHIAS, 1273 TONS DISPLACEMENT.
Length 204 ft., beam 32, draft 12.9. Built by Bath Iron Works, Bath, Me.
Copyright 1891, by J. S. Johnston, N. Y.

Whatever may have been its effect on Roach as an individual ship-builder, the general effect of this venture on American ship-building at large, and in the long run, was to give it a new lease of life, and inaugurate for it a new era of progress.

The reader will doubtless have perceived by this time that I am laying the foundation of an argument to the effect that ship-building, more than any other industry in this or any other country, is integral to the national welfare, prestige, and even political independence, and hence must always be, in the best and most patriotic sense, the *protégé* of the government. This I maintain strenuously, and I need only to call attention to the manifest results of the experience of other maritime nations to prove the truth of my premises and the soundness of my conclusions.

The government pursued its policy steadily ; not indeed liberally, as compared with other great maritime powers, but still steadily and consecutively. What was the result ?

By the time the third batch of ships was authorized, it appeared that American ship-building, with its contributory industries, which had groped in the dark in 1883, had by 1889 already outgrown the demand that created it. Never in the history of ship-building any-



U. S. CRUISER BALTIMORE, 4600 TONS DISPLACEMENT.
Length 327.6 ft., beam 48.8, draft 20.6. Built by Wm. Cramp & Sons, Phila., Pa.
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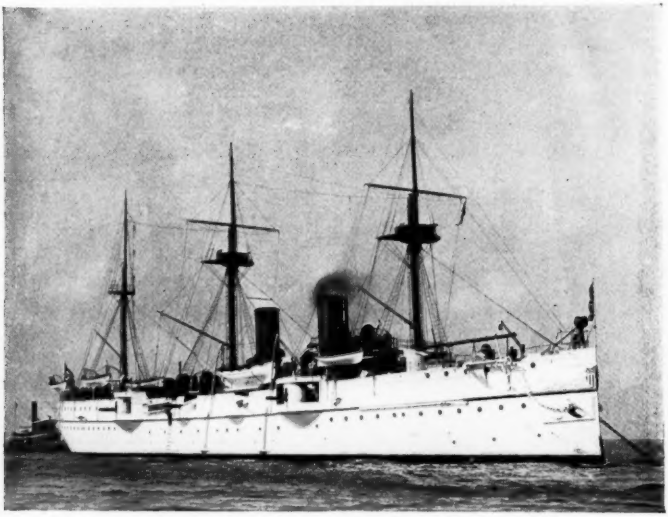
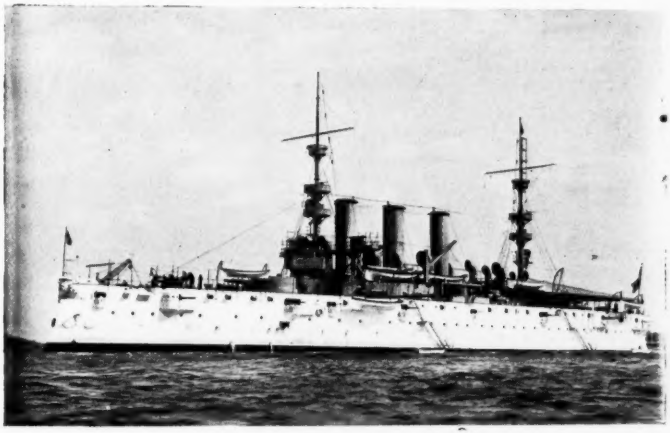


U. S. CRUISER SAN FRANCISCO, 4083 TONS DISPLACEMENT.
Length 310 ft., beam 49.2, draft 18.9. Built by Union Iron Works, San Francisco, Cal.
Copyright 1893, by J. S. Johnston, N. Y.

where had such progress in every direction and in every branch been seen; never had so small an impetus put in motion such giant forces Had bids for the construction of the New York and Olympia been invited five years sooner than they were, the contracts would have gone to England, or the ships remained in model or on tracing-paper. Had the bids for the construction of the first three battleships been invited in 1885 instead of 1890, American ship-building would have had a stroke of apoplexy due to surfeit. But five years of the progress of American ship-building, even under the meager encouragement offered, had made easy tasks of these battleships, and, instead of being surfeited, the industry already hungered for more.

The programme that eventuated in these three battle-ships was carefully thought out by Secretary B. F. Tracy, and he felt warranted in recommending the building of eight. Three were all that congress felt willing to authorize. It seems, in the light of the progress which is now a matter of history, that, had eight been authorized in 1890 instead of three, eight would now be in commission, or available for it, instead of three; and no one qualified to judge will gainsay that the capabilities of the ship-builders had been accurately gaged by the navy department.

It may be argued that the throwing of eight battle-ships on the market at that time would have acted as an over-stimulant to the development of the industry, with the consequent certain reaction.



U. S. BATTLE SHIP NEW YORK, 8480 TONS DISPLACEMENT.
Length 380.6 ft., beam 64.10, draft 23.10. Built by Wm. Cramp & Sons, Phila., Pa.
Copyright 1896, by J. S. Johnston, N. Y.

But I am neither offering or combatting purely speculative arguments. I am dealing only with accomplished facts and known performances.

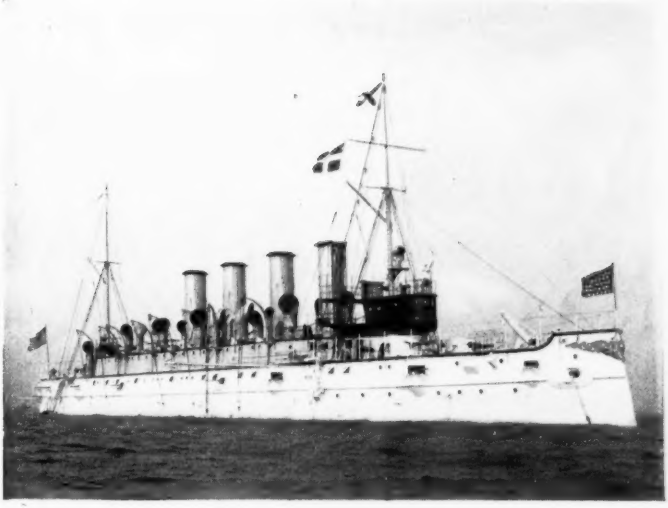
If we turn elsewhere for illustration or example, we shall find that twice, since we began our new navy, has England launched on her ship-building market single programmes of new construction exceeding in displacement and cost our entire fleet.

Before we began our new navy, Great Britain had the Bellerophon as flag-ship of her North Atlantic and West Indian Squadron, old even then, but more than a match for any vessel we possessed. But, as we have launched ship after ship, the English vessels on this station have been keeping pace with us in strength, and the successor to the Bellerophon, the splendid armored cruiser, Blake, has been succeeded by a battle-ship, since our Indiana was commissioned.

U. S. TORPEDO BOAT CUSHING, 116 TONS DISPLACEMENT.
Length 138.9 ft., beam 14.10, draft 5.3. Built by Herreshoff Mfg. Co., Bristol, R. I.

The inference is obvious. What we have seen and what we know requires no argument to establish; and we have seen and we know that the policy of the new navy, more than all other causes combined, has raised American ship-building from its struggle for existence a decade and a half ago to its exultant eminence of to-day.

The believer in free ships, however, says: Very well; admitting all these plain facts as far as the navy is concerned, what have they to do with commercial ship-building, or with the employment of American-built ships in peaceful traffic? The answer is that the New York, Columbia, Minneapolis, Indiana, Massachusetts, Brooklyn, and Iowa made the St. Louis and St. Paul possible; and they also made possible any needed number of St. Louises and St. Pauls, or better ships, in



U. S. BATTLE SHIP COLUMBIA, 7744 TONS DISPLACEMENT.
Length 412 ft., beam 58, draft 24. Built by Wm. Cramp & Sons, Phila., Pa.
Copyright 1895, by J. S. Johnston, N. Y.

U. S. BATTLE SHIP INDIANA, 10,288 TONS DISPLACEMENT.
Length 348 ft., beam 69.3, draft 24. Built by Wm. Cramp & Sons, Phila., Pa.
Copyright 1896, by J. S. Johnston, N. Y.

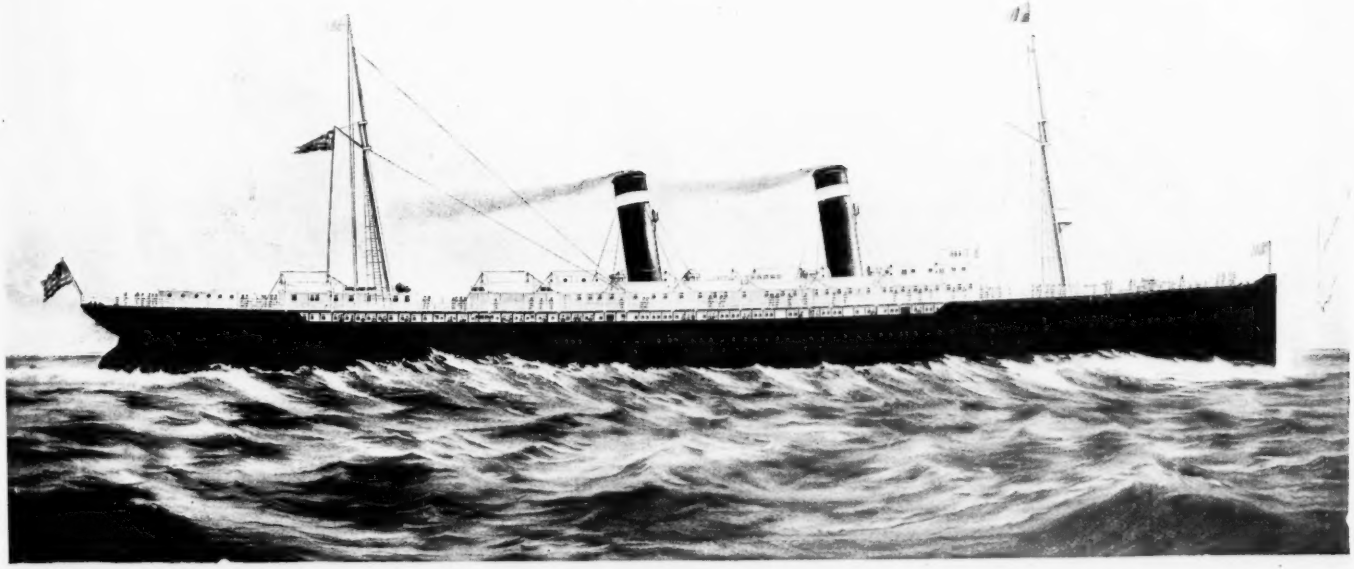
U. S. RAM KATAHDIN, 2155 TONS DISPLACEMENT.
Length 250.9 ft., beam 43.5, draft 15. Built by Bath Iron Works, Bath, Me.
Copyright 1896, by J. S. Johnston, N. Y.

the future. In a word, our policy of the new navy broke the back of England's ship-building monopoly, and broke it beyond cure.

If not, why are Japanese cruisers building in American shipyards?

Mr. Charles H. Cramp, in an article on the sea power of the United States, says: "We have made great and rapid progress during eight years of naval construction, but we have not yet rebuilt our navy. In fact, about all we can reasonably say is that we have conclusively demonstrated our domestic capacity to rebuild it."

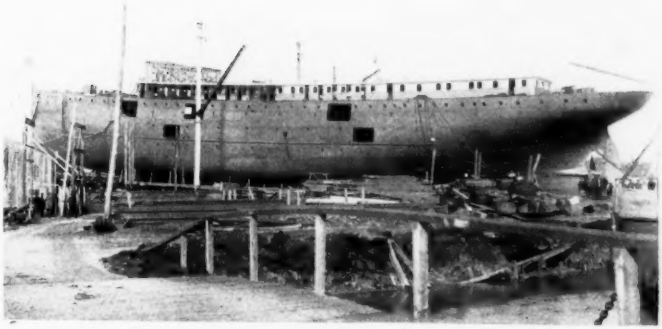
I have heard it said that, no matter what our progress in shipbuilding has been, we had to begin with English plans. Unquestionably English plans were procured at the start; so were French plans. But they were used for reference, not for imitation. No naval ship has been built exactly after any foreign plan. They have all been modified more or less. In fact, the object in having the foreign plans before us was to see what should be avoided as well as adopted, and in some cases the former desideratum proved the more important of the two. Foreign plans are as much sought after now as they were at the beginning, and for the same reason. But, withal, our best ships—the New York; the Columbia and Minneapolis; the Indiana class of battleships, the Iowa and Brooklyn; and the Kearsarge and Kentucky



THE AMERICAN LINE STEAMSHIP ST. LOUIS, 11,629 TONS.

Length 534 ft., beam 63, depth 42. 20,000 horse power. Built by Wm. Cramp & Sons, Phila., Pa.

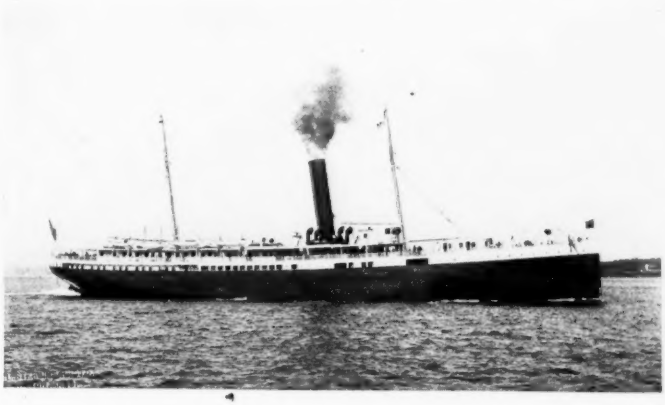
THE MAIN SALOON AND A PRIVATE SUITE, S.S. ST. LOUIS.



STR. HOWARD, 1757 TONS, MERCHANTS' & MINERS' TRANSPORTATION CO.
Length 270 ft., breadth 42, depth 26. Built by Harlan & Hollingsworth, Wilmington, Del.

—are distinctively American from keel to fighting tops,—hulls, machinery, and all. So also the Olympia, and most of our smaller ships.

I trust that I have made at least one point clear,—namely, that the vast progress in American ship-building since 1883 is due to the stimulus afforded by the naval policy of the government; that, in its ab-



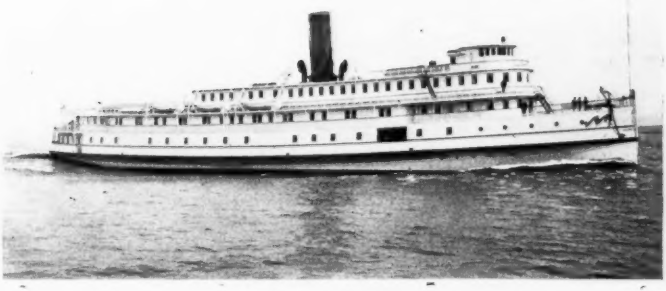
STR. YORKTOWN, 2126 TONS. OLD DOMINION LINE.
Length 298.5 ft., breadth 40, depth 34. Built by Delaware River I. S. B. & E. Co., Chester, Pa.

STR. EL NORTE, 2901 TONS. MORGAN LINE, SOUTHERN PACIFIC CO.

Length 380.5 ft., breadth 48, depth 23.9. Built by Newport News S. B & D D. Co., Newport News, Va.

CAR-FERRY STEAMER MARYLAND.

Built by Harlan & Hollingsworth, Wilmington, Del.

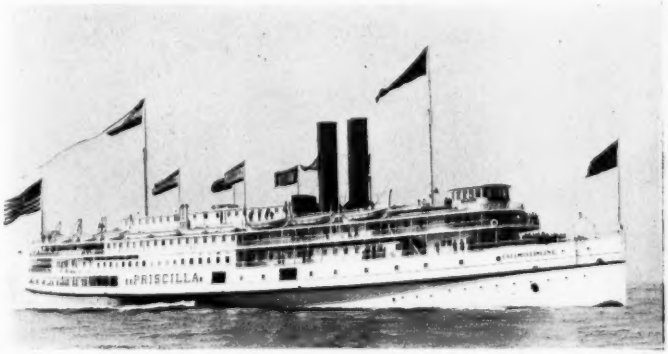


STR. MAINE, PROVIDENCE & STONINGTON S. S. CO.

Length 302 ft., breadth 44, depth 12.5. Built by Harlan & Hollingsworth, Wilmington, Del.

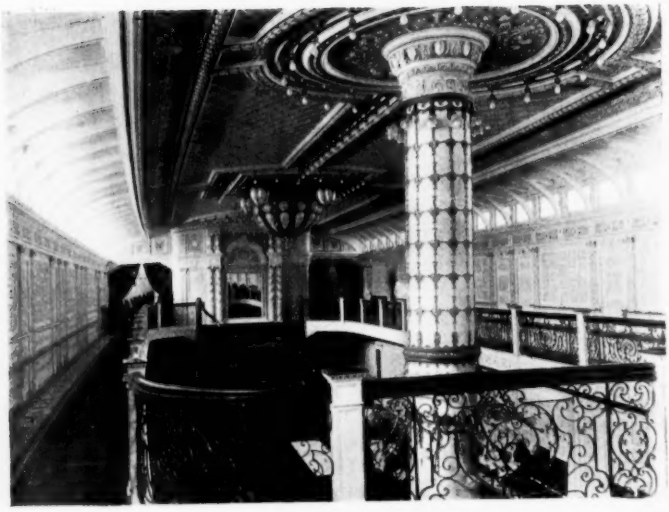
sence, and under impulse of the normal commercial demand alone, no such progress would have been possible; in fact, little or none at all in comparison with that observed elsewhere.

At this point I am likely to be interrupted by some western friend with the query: Why, then, has ship-building made such progress on the Great Lakes, where no part of the new navy has been built, and



STR. PRISCILLA, 2673 TONS. FALL RIVER LINE.

Length 425.8 ft., breadth 52.3, depth 18.3. Built by Delaware River I. S. B. & E. Co., Chester, Pa.



GRAND SALOON, STEAMER PRISCILLA.

MAIN COMPANION WAY, STEAMER MAINE.

where the stimulus of governmental policy has not been felt? Such a query betrays ignorance of, or indifference to, the actual state of things. As a matter of fact the fostering power of governmental policy in favor of Lake shipping and ship-building has been exhausted.

First, the Lake shipping enjoys the full and undisturbed benefit of the coast-trade laws.

Second, the terrific foreign competition that throws a constant shadow over the ocean is wholly absent from the Lakes.

Third, in the matter of harbor improvement and the bettering of waterways, the government has done everything for the Lakes that acute ingenuity could devise or dauntless means supply.

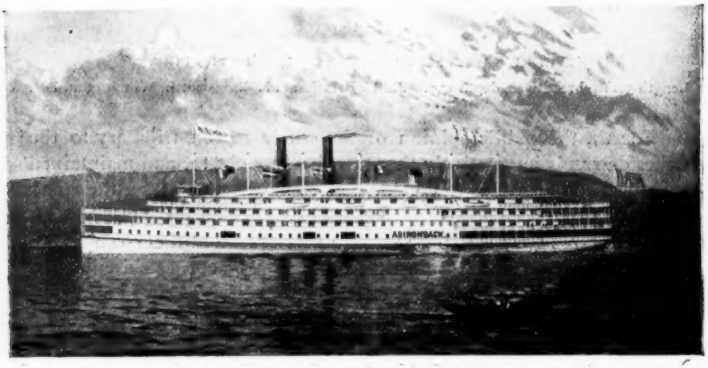
STR. RICHARD PECK, 1819 TONS. NEW HAVEN LINE.
Length 300 ft., breadth 48, depth 17.9. Built by Harlan & Hollingsworth, Wilmington, Del.

Fourth, the public opinion of the whole region tributary to the Lakes demands imperatively that they be brought to, and maintained in, a condition suitable to complete efficiency as a check on the trunk railway lines.

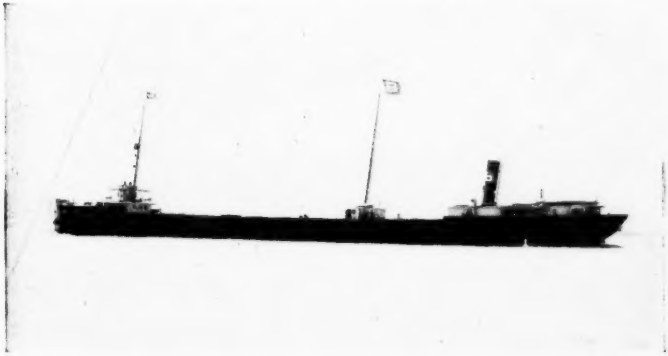
From these facts it will be at once perceived that there can be no common plane on which to institute comparison between shipping and ship building on the Lakes and on the two great salt-water coasts.

There is another prime consideration germane to the question of stimulus involved in the naval policy of the government,—the fact that, notwithstanding the feeble state of contributory industries at the outset, and the consequent necessity of initial development, the tests

LAUNCH OF THE STEAMER SIR WILLIAM FAIRBAIRN.
Built 1896 by the Detroit Dry Dock Co., Detroit, Mich.



HUDSON RIVER STEAMER ADIRONDACK, PEOPLE'S LINE.

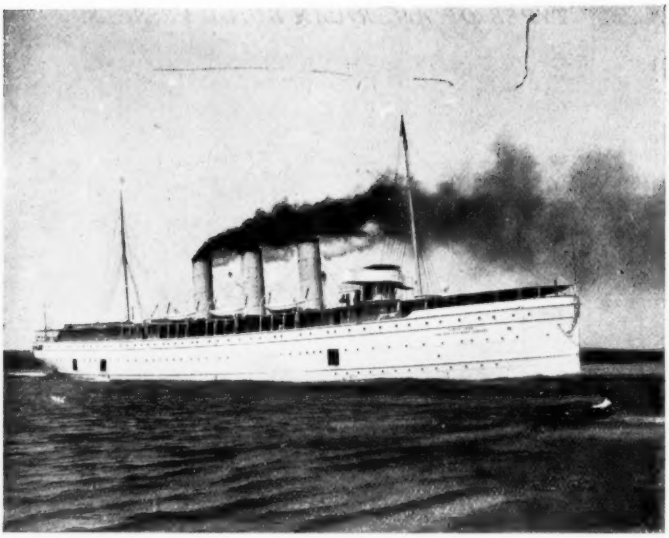


LAKE FREIGHTER SIR WILLIAM FAIRBAIRN.
Built by Detroit Dry Dock Co., Detroit, Mich.

prescribed for physical qualities of material used in our ships have constantly exceeded in severity and precision the tests of any other country.

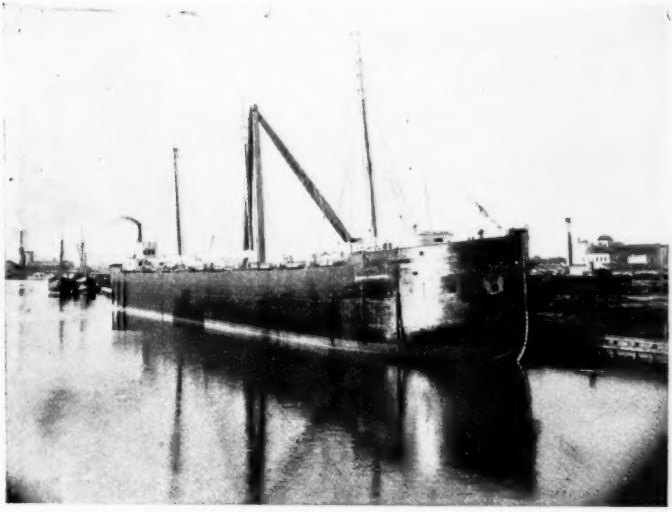
These requirements, unprecedented as they were at the time when they were prescribed, have been met and overcome, and to-day we can say with pride that, as the gratifying result of the unusual efforts thus induced among American manufacturers, the steel made for the navy and merchant vessels of the United States is far superior to that of any other nation. This is a result of value extending far beyond the single province of marine architecture.

THE MC DOUGALL FREIGHT WHALEBACK.
Built by American Steel Barge Co., West Superior, Wis.



STR. NORTH LAND, 4244 TONS. NORTHERN S. S. CO.
Length 383 feet, breadth 44, depth 26. Built by Globe Iron Works, Cleveland, O.

STR. SIR HENRY BESSEMER.,
A Typical Lake Ore-Carrier.



TOWING BARGE OR SCHOONER NIAGARA.
Built by Chicago Ship-Building Co., Chicago, Ill.

The total merchant marine of the United States for certain years is shown in the following table:

Year.	Number of vessels.	Tonnage.
1870	28,998	4,246,507
1880	24,712	4,068,034
1890	23,467	4,424,497
1895	23,240	4,635,960
1896	22,908	4,703,880

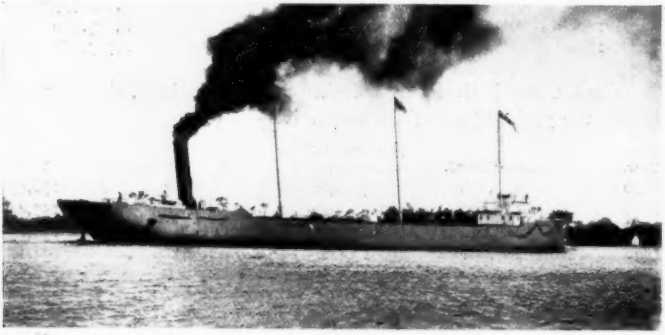
The tonnage built during certain years is as follows, the year ending on the 30th of June of the respective years:

Year.	On seaboard.	Mississippi River and tributaries.	Great Lakes.	Total.
1870	182,836	56,859	37,258	276,953
1880	101,720	32,791	22,899	157,410
1885	121,010	11,220	26,826	159,056
1890	169,091	16,506	108,526	294,123
1891	237,462	19,984	111,856	369,302
1892	138,863	14,801	45,969	199,633
1893	102,830	9,538	99,271	211,639
1894	80,099	9,111	41,985	131,195
1895	67,127	8,122	36,353	111,602
1896	102,544	15,771	108,782	227,097

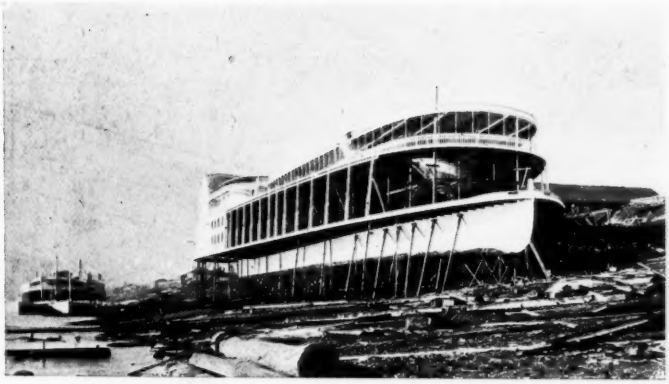
CAR FERRY SAINTE MARIE, 1357 TONS, IN 27 INCH ICE.
Length 502 feet, breadth 51.6, depth 24. Built by Detroit Dry Dock Co.

The value of the shipbuilding industry is shown below :

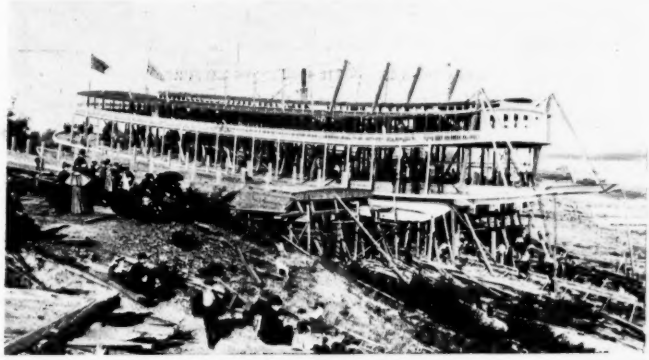
Year.	Capital invested in shipyards.	Number of employees.	Gross income of yards
1870	$ 9,102,335	11,063	$17,910,328
1880	20,979,874	21,345	36,800,327
1890	53,393,074	25,934	40,342,115



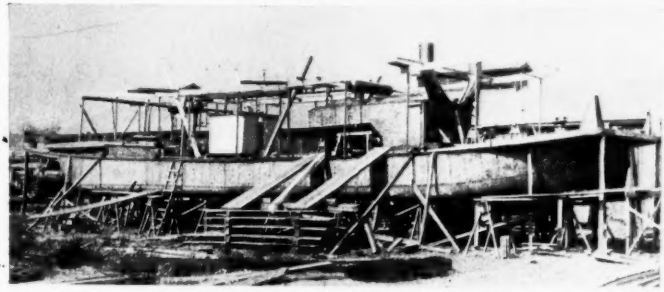
STR. ZENITH CITY. A TYPICAL LAKE FREIGHTER.
Built by Chicago Ship-Building Co., 1895.



OHIO RIVER PACKET CITY OF LOUISVILLE, 1681 TONS, ON THE STOCKS.
Length 301 feet, breadth 42, depth 7.



STEAMER BLUFF CITY, JUST BEFORE LAUNCHING.



A STEEL STEAMER FOR SHIPMENT TO MEXICO.

WESTERN RIVER VESSELS. HOWARD'S SHIPYARDS, JEFFERSONVILLE, IND.

STR. CAURA IN SOUTH AMERICAN WATERS.
Built at Crescent Shipyards, Elizabethport, N. J.

MC DOUGALL PASSENGER WHALEBACK CHRISTOPHER COLUMBUS, 1511 TONS.
Length 362 feet, breadth 42, depth 24. Built by American Steel Barge Co., West Superior, Wis.

On June 30, 1896, there were 1179 yachts, of an aggregate tonnage of 44,022, belonging to citizens of the United States.

The total value of all the vessels of the United States, including those belonging to the government is about $300,000,000.

So much for the progress of American ship-building in recent years. Briefly and cursorily I have outlined its causes, and indicated some of the difficulties and obstacles in spite of which it has been achieved. As it stands, it fills a splendid page in our national history, and the men who have been identified with it in any capacity may rest secure in the patriotic consciousness of having served their country well.

Coming now to the second division of my theme, I repeat my remark at the outset that the promise in American ship-building at this time is quite as speculative as the possible progress was when progress began.

Taking up the naval prospect first, it may be granted that, according to the average of qualified opinion, our modern navy, including the latest ships just contracted for, is about half-built or building. At all events, at least as much remains to be done as has been done, in point of number, tonnage, and cost of ships, before our establishment can reach the minimum status of readiness for war in time of peace. In what manner or to what extent from year to year the remaining half of the necessary programme will be executed, no one can foresee; but the fact that the destinies of American ship-building still hang largely on the future naval policy is as indisputable now as it was thirteen and a half years ago. If the policy proceeds with system and regularity, promise will continue to develop into progress, as heretofore. But any serious break in, or temporary abandonment of, the increase of the navy programme would be quickly and disastrously felt by American ship-builders; and not only by them, but likewise, in their train, by the almost innumerable throng of contributory or dependent industries.

Here it seems proper to devote a word to the contributory industries. No one will dispute the assertion that a country is better off with such establishments as the Bethlehem Iron Works, Carbon, Midvale, Carnegie's, Paxton's, the Illinois Steel Works, etc., than without them. The progress of these industries during the epoch of naval reconstruction has kept even pace with that of ship-building. They have had, indeed, other markets, but the market which, above all others, has challenged their enterprise, invoked their ambition, and stimulated their advancement has been that offered by ship- and engine-building. Any blow disastrous to the latter would be equally and instantly destructive to them. A majority of one vote in con-

gress against further prosecution of the prevailing naval policy would stop the 14,000-ton forging press at Bethlehem, silence the great rolls in Pittsburg, Cleveland, and Chicago, and check the hum of innumerable lesser wheels, as well as make grass grow in ship-yards.

The promise in American ship-building at the commercial end is by no means secure. More than one ship-yard in the United States could be named which is amply capable of meeting the whole probable commercial demand for new ships for the next ten years under existing conditions, so far as sea-going ships of, say, 2,000 tons register and upwards are concerned, exclusive, of course, of the Lakes. This assertion may startle men not intimately familiar with the state of the industry, but every ship-builder will accept it as the plainest of truisms.

It may be inferred from this that I consider the ship-building industry in America overdeveloped from the commercial point of view. Such inference would be wrong. The existing state of development as to facilities is no more than has been required—I might say, forced—by the demands of the navy. It is, therefore, normal and necessary. Hence the fault, if any, is not in overdevelopment of ship-building facilities. On the contrary, it is in the underdevelopment of commercial demand; and that underdevelopment is due to causes which can be removed only by betterment of the national policy in the direction of the merchant marine.

It must be borne in mind that we are dealing, so far as the ocean-carrying trade is concerned, with the fostered, encouraged, or subsidized merchant marines of England, France, Germany, and Japan, and, to a less, but still troublesome, extent, with those of the Scandinavian States, and Holland, whose cheaper labor and cheaper fare amount in the competition to more than a moderate subsidy. In this strife the American merchant marine is confronted with the problems of high wages and costly fare, without compensating conditions of any kind. A so-called subsidy law is in force; but it is so restricted in its application that but two steamship lines can derive any assistance from it, and even this assistance becomes pitiful when compared with the obstructive conditions that they have to surmount. In a word, the state of the American merchant marine is not calculated to cause any considerable or sustained demand for new construction in the sea-going classes, and hence, as a matter of course, there is little in that direction to offer promise to the ship-building of the future. This may not be a pleasant, and certainly is not an exhilarating, theme for a ship-builder, and it will probably add nothing to the sum total of the prevailing aspiration for a renewal of prosperity. Not until the rehabilitation of the American over-sea commerce is made a fixed national policy, ele-

vated above all questions of party expediency, in the carrying-out of which our diplomats and legislators shall be in hearty accord, can a healthy demand be created for ocean-going ships. Almost from the foundation of the republic we have been piling up treaties with almost every nation, the effect of which has been, and is, to reduce our merchant marine, alone of all our great national interests, to an even footing with the cheap-labor nations of the old world. The trouble lies more in our diplomacy than in our legislation. It seems that we are full of discrimination in favor of any and every one of our great industries, except that of ocean traffic. But, whenever it is proposed to discriminate in favor of that, the archives of the department of State open, and belch forth vetoes in the shape of forgotten treaties, in every one of which our birthright on the sea has been bartered away. In population, judged by the standard of average enlightenment; in area, judged by the standard of available productivity of soil; in wealth, judged by the standard of active capital and mobile resources,—we are undoubtedly the greatest nation on the earth; but the instant we touch salt water in the carrying trade, our treaties throw us upon the tender mercies of the humblest, as well as the proudest, States of Europe. The intelligent application of the proverb, "charity begins at home," would mean much to our commercial interests on the ocean.

From these deductions it is apparent that the existing state of our over-sea merchant marine is due to deep-seated and fundamental causes which cannot be adequately dispelled by any mere "Be it enacted." The conditions which confront us are epochal, not accidental. We have been supine, while others have been active; we have let our interests take care of themselves, while others have taken care of theirs; and we are now confronted with the inexorable result of our short-sighted and unpatriotic folly.

The task of national rescue from these sad and humiliating conditions is an herculean one. Whether or not our statecraft and diplomacy of the future will prove equal to it is something beyond my ken. But it is perfectly plain that persistence in the aimless, purposeless, and nerveless policies of the past not only will not effect the desired rescue, but must deepen the degradation.

We can find encouragement in one most important direction, despite this gloomy outlook. Causes already delineated have promoted the ship-building industry to a point where, quality of output being duly considered, it can compete on even terms with any and all comers. The disparity in first cost between American- and British-built ships of like classes has been so nearly eliminated by our recent phenomenal progress in the art, notwithstanding our higher wages,

that it has ceased to be an important factor in the situation. Merchant and steamship companies can now, all things considered, procure American-built ships as economically as ships of English build. This, of course, refers to the higher classifications. Hence the American ship-builder is ready to do his share towards resurrection of our sea-going merchant marine on the most favorable footing. But, as yet, the disparity between this country and England in the matter of cost of operating ships of like classes exists in full force,—in sufficient force to be practically prohibitory. For this reason, and for this alone, the facilities of the American ship-builder are not to any considerable extent, or with any encouraging continuity, called into requisition by the American ship-owner. This is not because the American ship-owner does not desire new ships, but because, under existing conditions of competition with rivals receiving substantial aid from their respective countries, he could not operate them profitably if he had them.

Thus the reader will perceive that, no matter from what point of view the situation is surveyed, or no matter at what admitted point of fact the train of reasoning may begin, the conclusion arrived at is always the same,—namely, that the future of American ship-building in any large sense depends upon the future of American traffic over sea; and that the future of over-sea traffic is wholly in the hands of our national statecraft and diplomacy.

So, while viewing the progress of American ship-building with exultant pride, let us look to its promise with fervent hope.

THE PROSPECTIVE RESUMPTION OF MINING ACTIVITY.

By David T. Day.

THE quantity and value of the mineral products of the United States form a good barometer of industrial prosperity. Mineral industries are more directly affected by commercial changes than almost any others, since the crude products of the mines serve as the starting-point for most manufacturing enterprises. Any industrial expansion must be anticipated by a correspondingly increased supply of the crude minerals necessarily involved. This is a different condition of affairs from that prevalent only a few years ago, and, in the minds of many, the mineral product still consists of whatever the prospector happens to discover and mine. To these mining means speculation,—nothing more. Perhaps even the majority of business men fail to recognize that there is less speculation about the coal product than in any agricultural crop, the volume of which is affected by every change in the weather,— accidents to which the miner is practically indifferent.

Formerly we mined what we could of our mineral wants, and imported the rest. Now, on the contrary, the United States is the greatest mineral producer, furnishing nearly two thirds of the world's petroleum, more than one half of all its copper, one third of the pig-iron and coal and nearly one fourth of the gold, iron-ore, and zinc. We export far greater values than we import. Not only are our mines well equipped, but the resources known, though undeveloped, give assurance of continued mineral supplies, even without the prospecting which, aided by more exact geological exploration, is constantly becoming more effective. One well-recognized condition necessary for mining prosperity is to find a market for the continually-growing supply. Full activity for the enormous mining plants of the country means great prosperity. But, after several years of declining industrial activity, a glance over the field shows a great aggregate of capital invested in idle mines and their accessories. That this is a serious, even critical, condition for the capital involved will be appreciated by considering the rapidity with which an idle mining plant depreciates. Mining machinery is rendered worthless more rapidly than that of a well-protected factory. Frequently the mine-water is so acid as to quickly corrode metals to a worthless condition, and in the deeper mines the

encroachment of water alone frequently amounts to more than the mineral is worth, and then a shut-down means abandonment.

The table given on a following page, showing the idle coal mines of the United States, is typical of the whole mining industry. With this condition of much idle capital waiting for an increased market, it is interesting, with the advent of a widely-announced era of general prosperity, to show in what channel the mining revival will be most evident and most important. That even the mere announcement of approaching prosperity will have this stimulating effect is undoubted. Usually a considerable period of time is required for the development work necessary before new mines can increase the mineral output, and the new demand from more active industries must be supplied from accumulated stocks with a corresponding appreciation of prices. But at present there is unusual ability on the part of idle mines, and still more on the part of those not working up to full capacity, to respond promptly to additional demand, and, on the other hand, the long-continued depression has discouraged the accumulation of stocks. The response from the mines will be unusually prompt. Whether for good or disaster, the year 1897 will witness the greatest experiment ever made as to the productive capacity of the mines. Increased prosperity must enter into all business calculation for 1897, for its demand for raw materials is severe and immediate, and must be anticipated.

To the average producer accustomed to forecast his market the meaning of the starting of three hundred industrial plants between election day and November 10, as shown by the New York *Commercial Bulletin*, is evident. For example, this prospective increased demand for raw material led at once to such activity in marketing the Lake Superior iron ores that lake freight rates have advanced, in spite of the accumulated supplies at Cleveland and other lower lake ports.

Among the plants which started into activity with the election it is significant that it was a blast furnace which Major McKinley selected as typical of productive industry, and, in spite of the preparation required for blowing in a furnace, on November 5, two days after the election, one was ready to kindle into activity at Tonawanda, New York, by an electric spark from Canton. But this was not an accidental condition. Many other furnaces and mills for iron and steel in Pennsylvania and the Ohio valleys were ready, and have since started. The president-elect selected the industry which has most promptly responded to the prospect for better times. The conservative tendency of the past three years is nowhere more evident than in the restricted use of iron and steel for all purposes. Some of these industries may be slow to respond,—the steel-rail industry, for example, since no considerable extension of railway mileage is yet in sight,—but for struc-

tural materials for large buildings, the erection of which has been greatly retarded by dull times, and for much-needed railway equipment, rolling stock, and bridge-work, the demand will be great. Mr. James M. Swank states that we may expect a decrease in the total product of pig iron for the year just closing. But this will bring out more sharply the contrast with the decided increase which, he admits, we may expect in 1897. It is difficult to guess at the exact measure of increase, but the figures for 1897 should come fully up to the record-making figures of 1895, and may go beyond them. While capital will not flow freely into new railway enterprises, as in other years, there is no reason to believe that there will be any cessation in the demand of steel for ship-building and for a thousand other uses. Prices must necessarily be higher in 1897 than to-day, but there will be no great advance, and there will be no boom, because of our very large capacity for the production of all forms of iron and steel.

Copper is another metal quick to respond to general trade activity. When we consider the recent advances in electrical development at Niagara, and reflect that this was impracticable without increasing the use of copper, and further the enormous amount of recent electric installation in mining plants alone, to say nothing of the greatest use in new trolley systems, it is evident that the draft on the copper market will be unusually large in the next twelve months. The experience of the present year has also developed an important export outlet for copper.

Mr. Kirchhoff, editor of the *Iron Age*, writes to me that the outlook for the copper industry is very favorable, since it is considered that there will be added to the extraordinary demand in Europe a rate of consumption in the United States more nearly approaching the normal. The amount of copper which has gone into the hands of consumers has been very large in Europe. Thus statistics show that the deliveries in England and France were 114,744 gross tons during the first ten months of 1896, as compared with 85,078 gross tons during the corresponding period of 1895. The visible supply in Liverpool, Swansea, London, and Havre was only 35,441 gross tons on November 1, 1896, against 50,250 tons on November 1, 1895. It is well known, although the exact figures are not available, that Germany, Russia, and Austria have taken an unusual amount of copper during the current year.

By far the heaviest contributor to the increased supplies in Europe have been the United States. During the first ten months of 1896 the exports from this country were 100,489 gross tons of copper,—a rate of 120,000 tons per annum. It is known that this quantity will be shipped this year, because the metal has been sold and freight-room

has been engaged. In 1895,—until then a banner year in the export movement,—the total shipments amounted to 64,722 gross tons. While in this direction there has been an enormous expansion, there has been a sharp decline in the home-consumption of copper. Leaving out of consideration the question of stocks, concerning which there are no reliable data whatever, the production figures collected by Mr. John Stanton furnish adequate data. During the first ten months of this year the home-production was 169,910 gross tons,—a rate of 200,000 tons per annum. Since the exports will amount to 120,000 tons, this leaves about 80,000 tons as the apparent home-consumption, ignoring stocks.

In 1895 the total production was 171,197 tons, of which 64,722 tons were exported, leaving the home-consumption at 106,475 tons. This is a decline of about 25,000 tons. With the restoration of confidence and a general moderate revival in business, leading to investment in electrical equipment, the home requirements ought, in 1897, to reach the 1895 standard, or even surpass it.

Since we know that the leading European industries are engaged even now for the whole of 1897, and some of them for 1898, it seems probable that larger quantities of copper will be needed, and that this must be coupled with a rise in prices. The latter are now low, so that there is room for a considerable rise before reaching prices likely to check consumption.

The general sympathetic effect of the expansion of one metal trade upon others of the same class will of itself suggest an expansion for lead, zinc, tin, antimony, and other minor metals during the year to come. Unfortunately we are in a condition only to lose by any prosperity which may come to the position of the tin-supply ; for there is no prospect of our being able to compete with the far richer tin deposits and much cheaper labor of East India. But the beneficial effect of prosperity to the tinplate trade will not only be felt by the vigorous, though new, tinplate manufacture here, but will be evinced by the demand for the necessary black plates, which make the most important raw material for tinplates.

Associated with the expansion of our steel industry comes greater demand for manganese and nickel, and even for chromium and tungsten, but of greater importance is the increased demand for limestone and for fuels, which must increase proportionately with the iron and steel.

The present condition of the idle mines in the coal industry is an interesting one, and well shown by the accompanying table prepared by Mr. E. W. Parker :

NUMBER OF COAL MINES IDLE IN 1895, WITH LATEST AMOUNT OF PRODUCTION REPORTED.

States.	Number of mines idle.	Probable production, if active.	Average product per mine.
		Tons.	Tons.
Alabama	8	71,740	8,968
California	2	6,080	3,040
Colorado	10	174,633	17,463
Indiana	7	125,496	17,928
Iowa	12	72,277	6,026
Kansas	12	78,804	6,567
Kentucky	4	109,030	27,257
Maryland	1	17,613	17,613
Missouri	24	79,915	3,313
Montana	7	79,011	11,287
New Mexico	2	280	140
Ohio	29	572,353	19,736
Pennsylvania	54	919,524	17,028
Tennessee	2	11,279	5,639
Utah	1	1,680	1,680
Virginia	6	19,061	3,177
Washington	3	31,453	10,484
West Virginia	14	207,715	14,837
Wyoming	8	6,140	768
Totals and average.	206	2,483,684	12,154

Estimating the idle mines in Illinois and those in in the anthracite region of Pennyslvania, we have more than two hundred and fifty entirely idle coal mines, which have in past years actually produced more than three million tons of coal. But to stop here would represent the industry in a better condition than the facts justify. A much more significant feature is furnished by the mines running on part time. Partial idleness, or even a very slight reduction in the working-force of one of our large mines, affects a State's product more seriously than shutting down a dozen local mines. Taking this into consideration, as well as the spectacle so frequently seen last winter at Jersey City and other terminal points,—of hundreds of cars of anthracite waiting for a market,—it is evident that an increase of twenty-five million tons of coal could be obtained in 1897 with practically the present plants.

At the October meeting of the Anthracite Coal Operators' Association, two plans were considered for extending the market for anthracite ; and, while these may both be laid aside temporarily, in view of prospective expansion in the ordinary channels of consumption, both merit careful thought in the future. The first plan reported was by Mr. N. W. Perry, for the conversion of anthracite culm into fuel gas. The report showed that, at the present valuation of culm banks,

this method of distributing energy is much cheaper for short distances than electric power from Niagara, and that for greater distances it may be economical to convert the culm into electric energy through the medium of fuel gas.

The report of a committee appointed to consider the project of exporting anthracite to Germany in competition with Welsh coal showed that this is at present ruled out by high ocean freights. The plan is full of suggestion, however, for the future.

There is another industry which has reached the stage of a great export movement,—that of crude and refined petroleum,—and, judging from recent developments, the increase in the exports of these oils during 1897 will materially add to our mining revival. Otherwise, the use of illuminating oils is so general and necessary as to make the industry much less dependent upon good times. Still, with any increased industrial activity, the amount of mineral oils used for lubricating machinery, and also the oils used in the wool, rope, leather, and many other industries, as well as the countless industrial demands for paraffin wax, add to the prosperity of the petroleum trade and to the price of the heavier crude oils.

The increased search for natural gas to compensate for a declining supply and greatly-increased demand is also of great benefit to the petroleum prospector. It is difficult to appreciate the great benefit of the oil- and gas-prospecting which is now developing regions of West Virginia, Kentucky, and Tennessee to a position they would not have reached in a century without the aid of a mineral industry.

Building and ornamental stones have felt the dull times to such an extent that the value of the annual product has gone down from over $48,000,000 to less than $35,000,000, the decline of almost thirty per cent. being both in quantity and price. Dr. William C. Day, of Swarthmore College, Pennsylvania, who is recognized as the authority on this subject, writes that an improvement in the stone industry during 1897 is almost inevitable. The feeling of uncertainty during the past few months has postponed many contracts, which will now go over into 1897, so that the latter year will, in effect, appropriate some of the industrial prosperity which under ordinary conditions would have belonged to 1896.

Granite and marble supply most of the demand for high-priced ornamental and monumental material, and therefore feel foreign competition more than any other kinds of stone, which are limited in their application to general structural, building, and other purposes, offering no special inducement for foreign material; hence a natural expectation of tariff support growing out of the election of Major McKinley will be immediately beneficial to the granite and marble industries.

Owing to a number of causes, the prices of both granite and marble have declined during the past five years. Improvements in quarrying, cutting, ornamenting, and polishing processes have undoubtedly had much to do with this decline in cost, but hard times and the desire to keep in operation even at nominal profits have conspired to the low returns. There will not be any great gain in prices in 1897, but the increased prosperity for the industry as a whole will be due to a greater volume of business. In this connection it is interesting to note that some marble producers who formerly marketed only ornamental, polished, or monumental stock are now turning their attention to the production of stone for building. Ornamental and polished granite columns are at present being utilized in whole blocks of houses built for renting, in some of our larger cities.

In the related clay industries there is the usual depressed condition, with an eager outlook for any possible expansion, as shown by the fact that, while last year we marketed the enormous value of $65,000,000 worth of brick and other clay products, the idle plants, according to Mr. Jefferson Middleton, of the United States Survey, could have brought this to over $80,000,000. A product of this value may be anticipated in 1897, and, indeed, noting that nearly all the active plants reported a product greatly below their capacity, a product of $100,000,000 is not improbable in a season of building activity.

No greater contrast can be drawn between the effects of prosperous conditions upon two different mineral industries than is to be seen in the cases of the building-stone and precious-metal industries The former is entirely dependent upon a market which comes with the increased building in a season of even moderate prosperity, while gold and silver, on the contrary, always have an abundant market, no matter how great a product. Still, even these are equally dependent upon the prevalence of prosperous industries to induce the investment of capital in producing them, and our gold and silver mines have felt the recent season of dull times as greatly as any other line of mining work. The prospector goes ahead in all seasons, unreasonably seeking deposits whether he can sell them or not, so that the present condition is one of countless undeveloped deposits of gold and silver, of greater or less importance, waiting for the necessary capital before a product can be realized.

Beside the well-recognized increase in mining activity in the Rocky mountain region, the opportunity for profitable investment in gold mining in the Piedmont region of the south must lead to much greater development. It is in this field that much prosperity must result from the use of new reduction-methods for refractory ores. There is no doubt that the expectations from the great cyanid process and re-

cent advances in chlorination have been altogether too sanguine. Nevertheless, the possibility of treating low-grade ores, practically tailings, by one or another of these devices is leading to more business-like methods in this entire field. That the result means a marked increase in the gold product in 1897 is undoubted.

The effect of recent progress in reducing mining costs should be dwelt upon at greater length than is possible here. But its contribution to mining prosperity can be appreciated, if we think of the possibilities offered for the cheap mining of non-Bessemer iron ores by the steam shovel in the Mesabi region, and for the cheap handling of these and other Lake ores by the system of ore docks on Lake Superior and by the Brown hoisting system at lower Lake ports. The savings effected by these improvements are comparable with the utilization of small sizes of anthracite coal, and the consequent decrease in the waste is from fifty per cent. to twenty per cent. of the total amount mined. This recalls the reduction in cost of electric energy at Niagara, and the consequently less cost of producing aluminum from its ores,—an effect which has already extended the use of this metal for household wares. Electro-chemical improvements in copper- and nickel-refining, and, more recently, in the alkali trade for producing chlorates, caustic alkali, and hydrochloric acid, are lessening the costs of mineral products, but greater than all these are the savings in power by electric installation in mines for haulage, drills, mining machines, hoisting, lighting, firing, and many other ways in regions where water power thus replaces costly fuel.

The saving effected by the introduction of the pneumatic tool in stone sculpture is extending the use of ornamental stone to ordinary buildings. This is small, however, compared to the general benefit secured by use of a greater quantity and superior quality of stone in road-building, in connection with the good roads movement.

Only enumerating such advances in mining and utilizing mineral products as the progressive substitution of pyrites for sulphur in the manufacture of sulphuric acid, the novel method of Frasch for producing sulphur in Louisiana, and his more valuable invention for removing this element from Ohio petroleum, which more than doubles our capacity for furnishing the best grade of illuminating oil, we point out in conclusion a modest, but ingenious, device,—a magnetic separator, brought forward by Messrs. Nitze and Wilkens, the economic effect of which will be felt in many industries in the year to come. By this machine it is practicable and, indeed, easy to remove any iron mineral (except sulphids), even carbonate or silicates, from mixtures of other materials,—an application of magnetism which is new and fairly sensational.

With the combined effect of more active industries and the consequent additional encouragement to the introduction of improved processes, the extent of our mining revival becomes an interesting study for the next twelve months. It is within the ability of the mines of the United States to expand their output within the range of from $500,000,000 to nearly $1,000,000,000 a year in the value of the crude product. We may be well satisfied with $700,000,000. If this is exceeded and the product safely disposed of, it means unprecedented prosperity, not only to the mines, but to the entire country.

The conditions call imperatively for an increase, a great increase, in mining activity in 1897. The product is now proportionately lower than it has ever been. In 1895 the total product was worth $622,687,668, while at the normal increase it should have been $670,000,000. In 1896 the situation will be still farther away from the normal, which would be $700,000,000. This means that the stocks have been so depleted, for most products, that an increase, and a great one, seems absolutely inevitable. The normal rate of increase has frequently been greatly exceeded. If one should hazard a guess as to the products which would make the greatest contribution to this gain, he would naturally select the precious metals. Newly discovered fields of unusual richness and old fields, now made valuable by great reduction in costs of mining and milling ores by the introduction of new or improved processes, are in a position to add to the product.

There is no considerable branch of the mining industry which has not felt the quickening effect of these economies, but the precious metals have been especially benefited. We do not refer to the record-breaking figures at which low grade quartz has been mined at a profit, but rather to the large bodies of low grade ore, as well as old waste dumps, which it has become possible to work profitably by the cyanide process which puts the low grade deposit in the attitude of a newly discovered store of wealth. Thus at Cripple Creek very little ore is shipped which carries less than $25 a ton in telluride of gold, although in most localities $7 ore would be shipped, and still poorer ore might pay expenses. Already there are large dumps at most of the Cripple Creek mines which exceed $7 in gold, and these must surely be used at future local cyanide mills.

Among the new gold fields of the United States, that at Gunnison, Colorado, and those in the Black Hills seem of unusual promise. Again, the reaction from the South African excitement is sending much capital into British Columbia, notably to Trail Creek. There is no question but that this camp will show a great increase next year, and as the branches from our own railroads are reaching into the region we will get the largest part of the ores to smelt.

THE WONDERFUL EXPANSION IN THE USE OF ELECTRIC POWER.

By Louis Bell.

THE transmission and distribution of energy is the latest of the great electrical arts. To be sure, in the almost prehistoric days before the invention of the dynamo, there were electric motors, as there were electric locomotives and electric lights, electric heaters and electric boats; but the ingenuity of Henry, Jacobi, Davidson, and Page led to no useful end. Their machines were relegated to the scrap-heap or the cabinet shelf by the same grim logic of economy that, in the fullness of time, has forced the modern motor into the front rank of industrial improvement.

When, just a quarter of a century ago, Gramme and Siemens gave the dynamo substantially its present form, every kind of electrical work received a sudden and powerful impetus. The subsequent half-dozen years were crowded with developments. In 1873 the first motor of modern type was put into operation at the Vienna Exposition by Fontaine and Breguet, the motor working a little pump through a mile or so of cable. In the next few years motors were occasionally exhibited or put to temporary use, but it was not until the autumn of 1878 that experiments and demonstrations culminated in commercial operation.

The time was propitious; the growth of electro-plating and electrotyping had given the dynamo-builders encouragement and occupation; the arc lamp had outgrown the laboratory and the lecture-room, and was becoming a practical illuminant. It was whispered, too, that, if the experiments then in progress on incandescent lamps were successful on a commercial scale, the problem of general electric lighting was to be at last accounted as solved.

More than this, some convenient and economical means of transmitting and distributing mechanical power had long been badly needed, and men were ready to turn hopefully to the potent force that had already achieved so much. Power transmission by wire ropes and by compressed air had already been weighed in the uncompromising balance of experience, and had been found wanting,— the former in flexibility, the latter in efficiency.

In the latter part of 1878 MM. Chrétien and Félix installed in the beet-sugar works at Sermaige the first commercial electric motor, operating a little hoist used in unloading the beets from the boats in

which they were brought down the river. During the succeeding winter four thousand tons of beets were thus unloaded, and the cost was found to be about forty per cent. less than unloading by hand The appearance of this historical motor is shown in Fig. 1. It developed only two or three horse power, and received its energy from a similar generator about twenty rods away. From this beginning has sprung the prodigious growth of to-day.

The next summer the first electric railway was put into operation at the Berlin Exhibition,—a single car, capable of carrying fifteen or twenty passengers, and running over fifty rods of track. The trans-

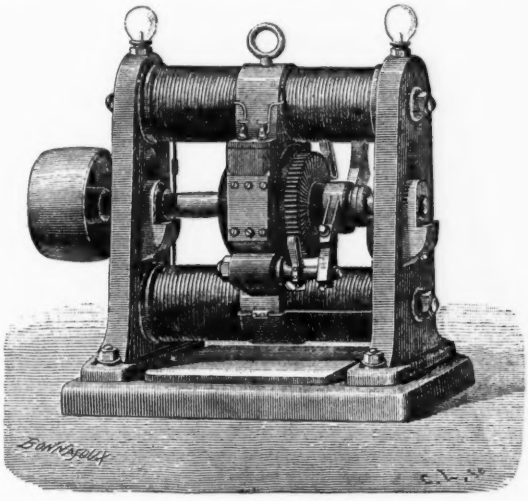


FIG. 1. ONE OF THE FIRST COMMERCIAL MOTORS

mission of energy to both stationary and moving motors was quickly taken up in this country. S. D. Field and Edison were pioneers in the work; in fact, the former was actively experimenting when the foreign work was made known; and presently scores of inventors were busy, with true Yankee push, in working out the manifold applications of electrical motive power.

At first the only available sources of current were the recently-established arc-light circuits. Upon these small motors began to appear soon after 1880, and with increasing frequency in the next succeeding years. Soon Edison lighting-stations became available, and during 1882 and 1883 small motors began to go into service in con-

nection with them. By the fall of 1884, when the Philadelphia Electrical Exhibition was in progress, the electric motor was firmly established as a machine commercially available, and its valuable properties were well understood. In fact, the Electrical Expositions of 1881 in Paris and 1882 in Munich had shown the capabilities of motor service, and at the latter had been shown the first experiment in long-distance power transmission,—an experiment more daring and revolutionary even than the famous one at Lauffen-Frankfort nine years later.

This work was done by Marcel Deprez, and consisted in the transmission of power from Miesbach to Munich, — thirty-seven miles, a distance longer than is spanned by any commercial plant in operation to-day. The line was of common telegraph wire, and the energy delivered was less than half a horse power, which was employed in driving a centrifugal pump. The voltage of the dynamo was about 1350, and both generator and motor were specially-wound Gramme machines. The station at Miesbach, the first power-transmission plant in the world, is shown above in Fig. 2.

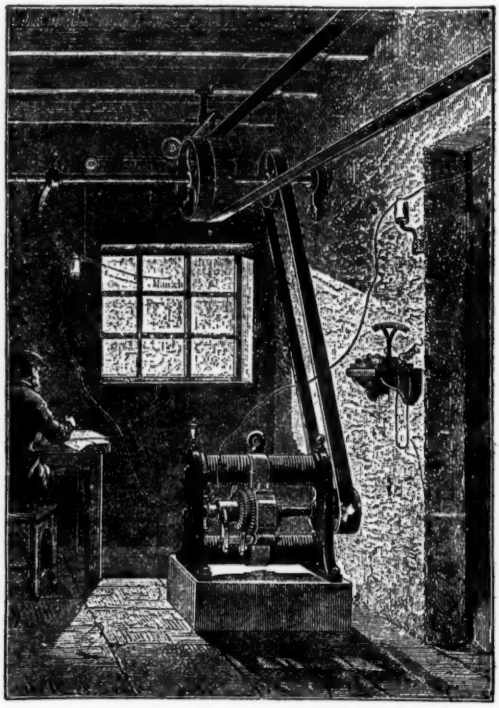


FIG. 2. THE MIESBACH POWER STATION.

From 1884 the development of the motor, following up the growth of electric lighting, was increasingly rapid, and by the autumn of 1886

it was estimated that there were no less than five thousand electric motors in use in the United States.

At the same period there were nine electric railways in operation, running fifty-eight motor cars and aggregating thirty-five and one-half miles of track. Many battery motors are included in this estimate, and the arc circuit was still an important source of power.

Thereafter the growth of the art was mainly in the direction of railway service, though the incandescent lighting stations soon began to take on motor service in considerable amounts.

In 1888 came the Tesla motor that has since played so important a part in the development of electric power, particularly in the past few years. As electric railways became more and more common, and engineers became more familiar with the construction and management of dynamos for fairly high voltages, motor work began to assume larger proportions and to reach out over greater distances. A few special motor circuits were installed at 220 and 500 volts, and a successful series motor distribution was started in San Francisco. But more experience was needed, and the time was not yet ripe, so that it was not until 1890 that power transmission as such began to gather headway. From 1890 dates the real period of industrial development.

By this time it was well ascertained that the electric motor was a thoroughly efficient and reliable machine, capable of being trusted with important work and fully able to compete with steam power under conditions that could often be realized. With power derived from ordinary central stations the motor was often far more economical in its operation than small steam engines with their attendant inconvenience and care; and it was obvious enough that no known means of transmitting power was so efficient or convenient for general purposes. Given a cheap source of power, the problem of its economical distribution was at last solved.

It was but natural that the mining regions of the far west, where coal was very expensive and water power plenty, should have been the scene of the first attempts at the electrical transmission of power. About the beginning of 1890 several transmission plants were put in operation, employing for the most part 500-volt railway generator and distributing power for mills, pumps, and hoists. This was only a useful makeshift, and it was necessary to break away from ordinary voltages before power transmission could assume the industrial importance that is its due. The step was not an easy one, for high voltage was a dreadful bug-a-boo in 1890; but taken it was, both with continuous and with alternating currents, and early in the next season two notable plants went into operation: one at the Dalmatia Mine, Califor-

nia, transmitting 100 h. p. at 1,800 volts 1½ miles; the other at Telluride, Col., delivering a similar amount of power 2½ miles away by means of a monophase alternating current at an effective pressure of 3,000 volts. A single synchronous motor was used, brought up to speed by a Tesla split-phase starting motor. At the Dalmatia Mine Brush continuous-current machines were used, one at each end of the line.

The polyphase systems were as yet undeveloped, as shown by the use of monophase current instead; but the Tesla motor had already been in use, for in the summer of 1890 several Hercules mining machines had been equipped with them and put into regular service near Pittsburg. One of these pioneer machines—the first commercial polyphase induction motor—is shown in Fig. 3. Then, in the summer of 1891, came the Frankfort Electrical Exhibition, which gave to electric power development the final impulse needed. Since then the transmission work in this country has been, with a few trivial exceptions, entirely polyphase. The next year saw much experimentation, much growth of ordinary motor service, but no power-transmission plants, save a small monophase synchronous one at Walla Walla, Washington, and another, closely similar to the Telluride plant, but of double the capacity, and working over a line 12½ miles long, at Bodie, Cal. A notable step was taken, however, in the establishment of a long-distance lighting plant, delivering energy from the generating plant in San Antonio Cañon to the towns of Pomona and San Bernar-

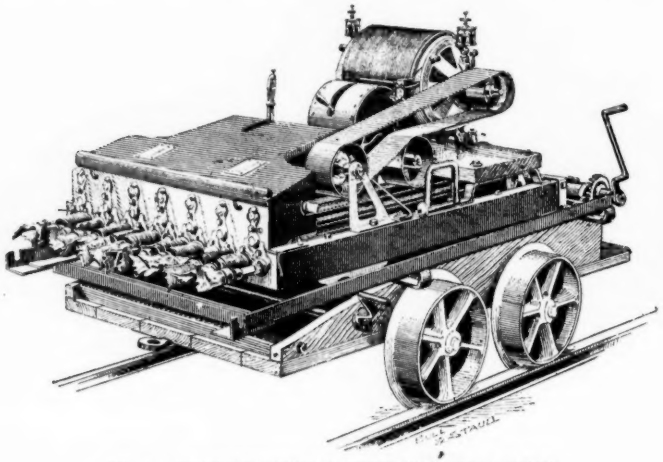


FIG. 3. HERCULES MINING-MACHINE WITH TESLA MOTOR.

FIG. 4. POMONA TYPE TRANSFORMER.

dino, Cal., distant respectively 13¾ and 28¾ miles. An ordinary alternating generator was used, but the voltage was raised to 10,000 volts by a bank of twenty step-up transformers in series. It was the first commercial use of so high a pressure, and the extreme distance of transmission has been exceeded only within the past year. One of these historical raising transformers is shown in Fig. 4.

The hard times were now drawing near, but the good work went along, and 1893 saw marked and substantial progress in the use of electric motive power. Not only was there steady increase in the installation of motors for every purpose, but the Columbian Exposition was rich in transmission apparatus, and before the end of the year three polyphase plants had gone into service, and—what was worthy of special note—the final steps had been taken to furnish the great Niagara plant with generators of American design and manufacture.

During the times of dire financial stress in 1893 and 1894, when many industries were completely prostrated, the electrical distribution of power grew as it had never grown before. Business men saw an opportunity of reducing operating expenses by securing cheap power, and grasped it. Aside from all the motors sold for factories

and work-shops, contracts were made by the leading electrical companies for more than a score of polyphase transmission plants.

Notable among these were two great cotton mills at Columbia and Pelzer, S. C., equipped throughout with polyphase motors, for the most part applied directly to groups of machines, dispensing with the costly and complicated systems of belting and shafting heretofore used in such factories. Fig. 5 shows the generating plant at Pelzer, with its three 750-kilowatt three-phase generators, directly coupled to turbines, delivering current at 3,300 volts to the mills 3½ miles away.

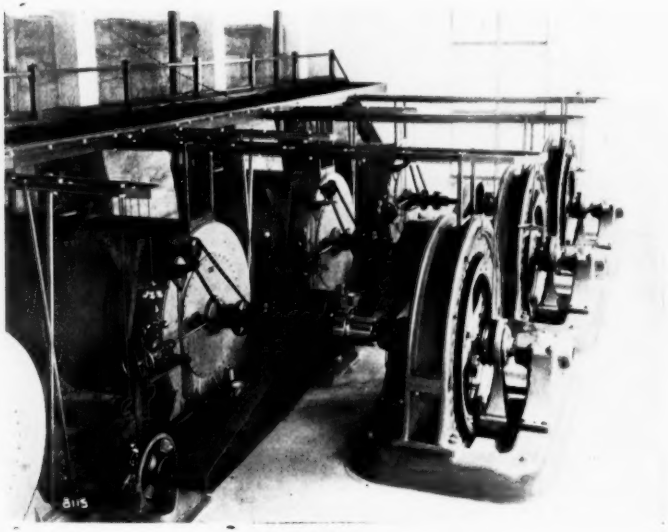


FIG. 5 THE PELZER DYNAMO ROOM.

The next year saw increased activity and epoch-making work. In the early summer the Folsom-Sacramento three-phase plant went into operation, of 3,000 kilowatts capacity, furnishing all the power and light used in Sacramento 23 miles away,—the longest commercial transmission that had yet been installed. A little later the huge Niagara plant went into operation with its 5,000-h. p. generators,—an installation that for size and startling engineering features will stand unique for many a year to come. Fig. 6 shows the present appearance of this immense station, of which so much has been heard of late that further description is needless.

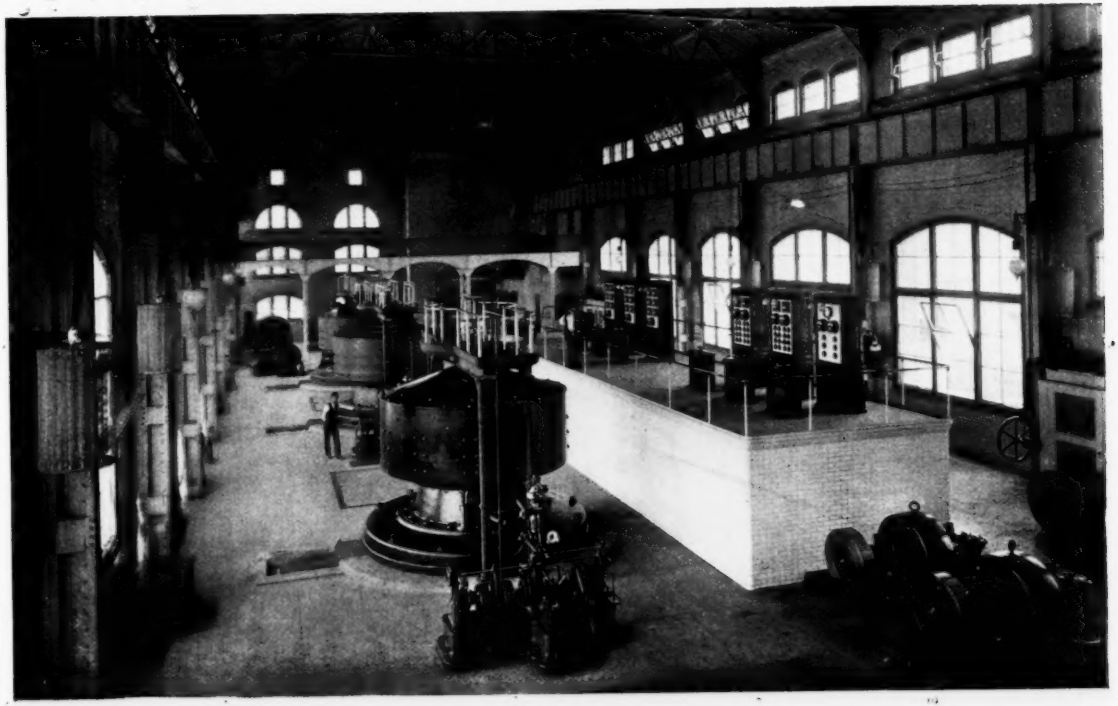


FIG. 6. INTERIOR OF THE GREAT NIAGARA POWER STATION.

In early autumn another sensational advance was scored in the starting of the enormous electric locomotives in the Baltimore & Ohio tunnel under the city of Baltimore. These colossal machines more than equalled in power the largest freight locomotives in existence, and their performance made the first great inroad into the realm of heavy railroad work,—an incursion that will be pushed into the very citadel of steam. Fig. 7 shows one of these locomotives, weighing 96 tons, and with a draw bar pull of more than 60,000 pounds.

Motor plants of every kind have multiplied, and the past year has seen greater progress than any which preceded it. Specially notable has been the transmission of power 35 miles into Fresno, Cal., at 11,000 volts,—the longest commercial transmission yet accomplished

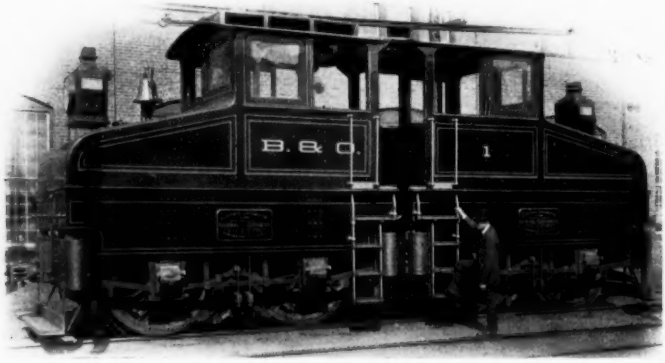


FIG. 7. BALTIMORE AND OHIO ELECTRIC LOCOMOTIVE.

anywhere ; and very recently the long-delayed delivery of power from Niagara to Buffalo,—1,000 h. p. over a 27-mile line, with immense increase in immediate prospect.

And through all this growth one fact has been conspicuous ; wherever electric power has come, it has found a profitable market ; the steam engine has gone out, and the electric motor has come in. There has been no failure, no long struggle with unprofitable conditions ; the motor has done its work, and pushed its competitors to the wall.

It is hard, indeed, to estimate the growth of electric motive power during the last decade. In place of the little group of struggling electric roads of ten years ago, we have to-day very nearly 13,000 miles of track equipped with not less than 30,000 motor cars. The railway motors in use aggregate fully a million horse power, and the generating plants close to five hundred thousand.

During the year just past, about 1,900 miles of electric-railway track have been built, and nearly 5,000 motor cars have been added to the equipment list. This increase means an aggregate investment of something like $35,000,000,—a prodigious sum to be added to a single industry in a year that has been far from prosperous.

Of stationary electric motors the number defies exact calculation, in so many directions and from so many sources has the growth extended. A single plant in New York city carries nearly 10,000 h. p. in motors upon its circuits, and the aggregate of those thus operated from central stations primarily intended for lighting certainly reaches 100,000 h. p. Those operated by scattered stations and power-transmission plants, and used in miscellaneous ways, bring the probable total amount of power to 250,000 h. p. Including railway work, it is safe to say that the gross power of the electric motors used in the United States is at present not less than 1,250,000 h. p. Of power-transmission plants proper, inaugurated mainly for motor purposes, there are now probably 150,—about 100 of them using the modern polyphase systems, which, by simplifying the question of distribution, have made power transmission practicable. A score of these plants transmit power 10 miles or more, and half a dozen over 20 miles. When we compare such a list with the little group of small power plants that were running five years ago, the strength of the cause that has scored such gains in times so troublous is self-evident.

The secret of this astonishing growth lies in the simple fact that capital will be invested to effect certain retrenchment even when it cannot be obtained for any other purpose. In prosperity men will work harder to make a dollar than to save one; in adversity this tendency is reversed.

The saving secured by the use of electric power is so considerable in many cases that ordinary prudence has demanded a sufficient investment to secure this advantage. One of the mining plants to which reference has been made has been paying for itself at the rate of five per cent. a month. Under many conditions electric power must now be regarded as an industrial necessity. Its position is secure, and the burden of proof rests to-day upon those who doubt.

For the future the outlook is bright. The pioneering period has gone by, and present successes render argument needless. The growth of the next few years will be along two lines. First, we shall see an enormous extension of electric-railway work. The steam railroads are beginning to submit to the inevitable, and one by one we shall see them employing electricity, certainly for branch and suburban service, perhaps even on long lines.

When the public wants an express service at 100 miles per hour,

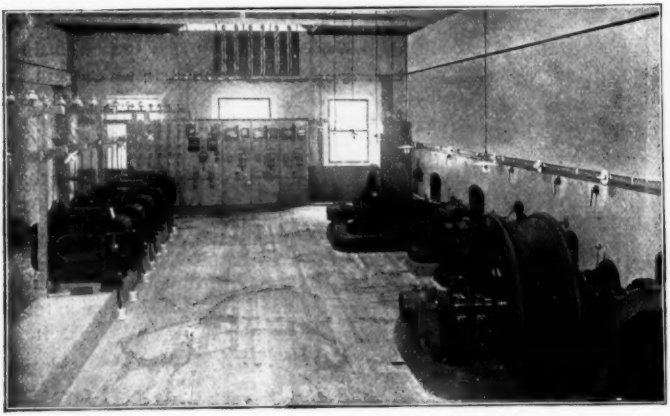
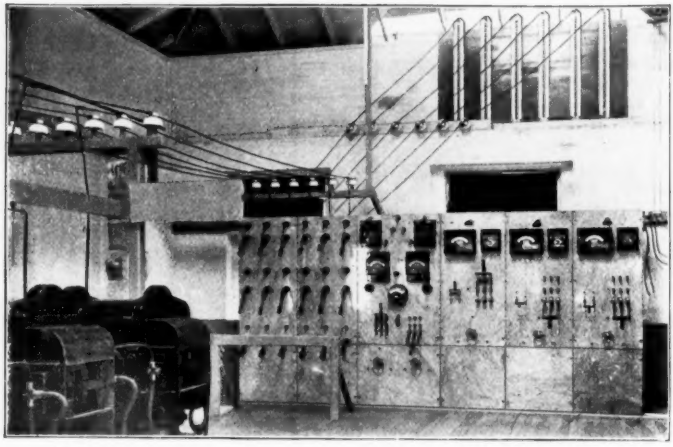


FIG. 8. THE GENERATOR ROOM OF THE FRESNO POWER-PLANT.

the means is at hand, and very little experimenting will have to be done. Not less important in its effect on the people is the growth of small electric roads in the country districts, tending to check the centralization of population and industry that is so grave a cause for anxiety in our national growth.



HIGH TENSION LINES LEADING FROM THE FRESNO STATION.

Second, there will be in the immediate future an immense development of the natural power resources of the country. One of the curious results of the power-transmission work already accomplished has been the rediscovery of numerous water powers which were quite forgotten until electrical power transmission called attention to them. Some of these have lurked in the most unsuspected places, where all the conspicuous powers had long ago been utilized. There are unemployed water powers enough within fifty miles of New York to displace every steam engine in the metropolis at a profit, if they were but rendered available.

It is now certain that the distance mentioned can be successfully overcome by apparatus already available. The recent transmission of power 35 miles into Fresno, Cal., already mentioned, has made clear the way, and no appreciable difficulties can be met in fifteen or twenty miles more. This Fresno plant, notable as the longest transmission in the world, is worthy of further description. The power house far up among the hills is shown in Fig. 8. The motive power is obtained from Pelton wheels working under an effective head of more than 1,400 feet. Each wheel is directly coupled to a three-phase generator, delivering current to the raising transformers at a pressure of 700 volts. It leaves the transformers at 11,000 volts for its long line through the foot hills and the San Joaquin valley into Fresno.

The present transmission is about 1,000 h. p., devoted to the distribution of light and power in Fresno and neighboring towns. Until this line went into operation, there was some distrust of very-long-distance work, some fears of unexpected and unpleasant developments that might be met on very long alternating-current circuits. These fears have now been finally dispelled by success, and, long before the power of Niagara was delivered in Buffalo, the success of that momentous enterprise was made certain, so far as electrical difficulties go, by the experience acquired in distant California.

With the power of overcoming long distances that has now been gained, a field is opened for the employment of electric power, the extent of which nothing short of prophesy can estimate. Not less than 5,000,000 hydraulic h. p. is ready to be utilized in this country of ours, when industry calls for it. Water power, to be sure, is not invariably a cheaper source of energy than coal, but the chances are generally in its favor.

And when water power is unavailable, there remains the splendid possibility of transmitting electrical energy instead of hauling coal,—taking the fuel at the pit's mouth and using it to spin electric motors in the thousand factories of a city fifty or one hundred miles away. The first steps have been taken in this direction already, and some

progress, at least, is certain. The time has come when cities will begin to defend themselves against the defilement of the free air. The smoke palls that hang gloomily over most large cities are blots on our boasted civilization, and they are to-day without the excuse of necessity or economy. More than this, they have passed beyond the bounds of toleration, and the general tendency of municipal legislation is now to enforce the remedy which hygiene, comfort, and domestic economy unite in demanding.

There is no good reason why every wheel that turns within the limits of a large city should not derive its motive power from a plant far beyond the city limits. Moreover, at prices now reached not infrequently by electrical-transmission plants, heating by electricity becomes economically practicable. With heat, light, and power derived from a single great plant, almost ideal conditions are realized, and such a possibility is now within our reach. When so splendid a goal is in sight, there is little chance that the advantage already gained will be lost through slothfulness and neglect, and for the great tasks pertaining to human industry electrical power will ere long have no serious competitor.

The illustrations of the Miesbach power station and the Hercules mining machine are republished by permission of *The Electrical World*.

THE STIMULUS OF COMPETITION IN ARCHITECTURAL CONSTRUCTION.

By Dankmar Adler.

HOWEVER the outward surroundings of the men of to-day may differ from those of the men whose existence was coeval with the dawn of civilization ; however man's command over the animate and inanimate world and over the forces of nature may have increased since he first sought shelter from the elements and protection against the attacks of wild beasts,—the underlying traits, instincts, and emotions of human nature remain unchanged, and are as potent to-day as they were in the time of contemporaries of the cave-bear and the mammoth.

Dissatisfaction with things existing ; hope for betterment from things to be worked for and attained ; observation, invention, imitation, emulation,—all these distinguish man from the most intelligent of beasts ; and the exercise and development of these tendencies and faculties have brought mankind to conditions of life and power so different from those of even the noblest animals that the idea of common origin of man and beast seems preposterous to many well-informed and thinking persons.

When the possibility of obtaining protection and shelter in walled and roofed enclosures first dawned upon primeval man, the initial and most important step toward the subjugation of the rest of creation was taken by our ancestors. Excepting only the discovery of fire, no invention or discovery has been more fruitful of results than was the invention and discovery of the house, however primitive and rudimentary may have been the form in which it first appeared among men. And from the day of the first utilization of a cave as a human habitation ; from the hour when the first crude hut protected a human family from the scorching sun and pelting rain ; from the time when walls of rocks, of mud, or of logs, first gave protection and vantage to man in his struggle with the wild beast,—the history of the development and progress of the human race has been coincident with the development and progress of the art and science of building. The fathers whose ingenuity and industry provided the most efficient shelter were able to rear offspring more numerous and more healthy and strong than their less ingenious and less industrious competitors in the struggle for existence. So also in the care of herds and flocks, in their shelter from wind and rain and snow and their protection against the

attacks of wolves and other natural enemies, and in the struggle of men against each other, success and fortune were ever with those who knew how to rear the sheltering and protecting structures best adapted to their various functions. And thus the families, tribes, and nations by whom the art of building was most assiduously cultivated were those which waxed most numerous, prosperous, and strong, while the families and tribes who were content to exist without artificial shelter, or were satisfied with the rudiments of hut- and house-building, became extinct; or, if their existence was prolonged, it was often in servitude and slavery to those more intelligent and industrious tribes and nations by whom architecture had been originated, developed, and cultivated. While it is true that hardy hosts of cave- and hut-inhabiting barbarians, envious and covetous of the comfort and wealth of the highly-prosperous house-dwellers of Assyria, Babylon, Egypt, Troy, Greece, Rome, and scores of other civilizations swooped down upon and overran and conquered their more highly civilized, but much less numerous, neighbors by sheer force of numbers, it is also true that these barbarians were themselves captured and overmastered by the civilizations whose creators and conservators they had set out to annihilate, and whose fruits and products they had come to appropriate. For among the first lessons of civilization learned by the conquering barbarians was appreciation of the advantages of dwelling in houses, of fighting behind fortifications, and of worshipping their gods in temples. They took up the architectural methods of the vanquished peoples, engrafted their own crude vigor upon them, and worked out new styles in harmony with their own individualities.

Thus, while nations perished, the art of building lived on to continually wider and more diversified development, always modifying and adapting itself to the dominating requirements and conditions of the changing times and periods and always continuing an essential factor in the struggle for existence and for the survival of the fittest among men.

Of the various forms in which records of bygone ages and races have been preserved for our instruction, none is more prolific of information as to what manner of people lived in the past, and what were their customs, manners, and characters, than their architecture, as it reveals itself to us in the remains of the public and private buildings, and of the roads, bridges, and aqueducts of communities once made up of people to whom steam and electricity, the railroad and telegraph, the compass, the steamship, the rolling-mill, the converter, the telephone, the sewing-machine, and the type-writer were unknown, but whose emotions, impulses, and passions, as revealed to us by their architectural remains, were very much the same as our own.

The house was man's first fixed possession, and its existence gave the first title to the ownership of land; and with that ownership a shelter from behind whose walls ownership of ground and house and the possession of the contained goods and chattels and surrounding fields and flocks could be advantageously defended. Rivalry and competition in the effort to select the best possible sites and to build the best possible houses must have begun at a very early day, and must have been strongest among the families which succeeded in surpassing other in increase of numbers and maintenance of health, strength, and wealth; the dignity of the family being indicated by the size, solidity, and ornateness of its domicile, and the number of families thus distinguishing themselves being in its turn indicative of the power and standing of the tribe or nation. It was then but a step to corresponding rivalry and competition in the efforts to erect temples for the worship of the family and tribal deities; and the greatness and power of the various gods was measured by the size and splendor of the temples erected in their honor. And, after civic pride had come into being, the wealth and the glory of the cities were emphasized, not only by the character of the habitations of their citizens and by the number and splendor of their temples, but by their council-houses and theatres, bath-houses, aqueducts, ways and roads of communication, bridges, and other public works, the extent and character of which, in each community and in every epoch, give testimony to the existence of most intense rivalry and competition. This emulation and strife, the competition born of "the divine spirit of discontent," was strongest among the families, tribes, and nations that rose to the higher level of civilization, and among these the desire of every man to excel his neighbor was most potent in its manifestations. These characteristics have gathered strength from age to age, and are still among the most powerful of the many forces which work for the continued advancement of the human race.

The desire to use architectural works as a means of aiding and furthering human progress and of celebrating and commemorating human attainments and triumphs has always found utterance during times of peace and prosperity, and has been repressed during the prevalence of war, or other disasters or general disturbances of public well-being, and has again developed and manifested itself upon the return of peace and prosperity.

The unremitting daily toil of the millions of workers of the world is chiefly expended upon the maintenance in physical comfort of the human race, and each day is witness of the consumption and consequent annihilation of the greater part of the product of the day before. Yet there is always in times of prosperity an overproduction, from

which arises an accumulation of the products of human industry sufficient to supply sustenance for the constant increase of the world's population, and to carry us over periods of disaster and distress. The daily production of things to be consumed on the morrow is indispensable to man's maintenance on the earth, but only that which is not consumed, but stored up for future use, contributes and adds to man's and the world's wealth. In all that can be used as food or as apparel for man or to minister to man's comfort and welfare, overproduction is not the bugaboo which thoughtless writers and speakers would have us believe it to be. On the contrary, it is only a wholesome preparation made in the years of "the fat kine" for the period of "the lean kine," which has repeated itself over and over again both before and since the days of Joseph and Pharaoh.

There is, however, a kind of overproduction, or, rather, malproduction, which is synonymous with waste, and which, strange as it may appear, is due to man's restless activity, ingenuity, and progressiveness. It is found in the many tools, machines, and processes for doing the world's work which, before having outlived their normal period of usefulness, are supplanted by others better adapted to their essential requirements and functions. Many products and appliances turned out by human industry, but which are ill adapted to their intended purposes and uses, should also be classed as malproductions. Financial crises are not caused by excessive yields of food products, or of wool and cotton and leather, or of metals from our mines. But, when the accumulations of the world's surplus earnings, actual and prospective, are expended and pledged in payment for proposed new and improved means and aids to production, communication, and transportation, and when these are in excess of what the world can utilize within a reasonable time, or are intended to supplement and supplant other means of service still capable of further utilization, and when errors of judgment like these have been committed on a large scale, and there is also a great volume of malproductions of the character before referred to, then the waste of energy and the impairment of accumulated wealth assume alarming proportions, and panic and disaster ensue. Everything that cannot be immediately utilized becomes unnegotiable and valueless, and even those things for which an immediate demand exists cannot be sold or pledged for their actual intrinsic value.

Heretofore architectural structures of all kinds were almost altogether exempt from these mutations of value, and appear to have stood through the stress of panics and financial depressions as fixed representatives of accumulated solid wealth. Until the latter half of the present century, the evolution of new conditions and wants among

men was slow, changes were few and far between, and stability of essential characteristics prevailed and was represented and illustrated in the architectural expression and development of the past. A house or building of any kind once built, a bridge or road once constructed and kept in good repair, were depended upon to maintain their value for an indefinite period, and their ownership was for ages the favorite form of investment for the accumulated wealth of the strong and thrifty, considered assailable only by the destructive agency of war.

The development of new industrial and commercial conditions and the accompanying enormous increase of accumulated wealth have brought about a readjustment of standards of utility, and therefore of the value of buildings and structures,—a wholesale abandonment and demolition of houses, bridges, aqueducts, and other architectural works, and their replacement by others intended to be better adapted to present and future conditions than their predecessors.

It must not be inferred from this that architecture is losing its character as the chief and final depository of man's accumulated wealth, as the enduring monument and final expression of the powers of achievement of its age and period, but if architecture is to continue its former relations to human achievement and progress, it must accelerate its pace to that of the man of the nineteenth and twentieth centuries, and, in order to continue its time-honored functions, it must adapt itself to the quickened movements and impulses of the new day. The effort to do this has undoubtedly been made, and visible progress has been achieved toward the solution of the problem how to reconcile the ideas of permanence, stability, monumentalism, with the spirit of skepticism, inquiry, change, and progress, which characterizes our period of the world's history. We cannot, however, close our eyes to the fact that architecture has contributed its share to that aggregate of malproduction which was one of the chief causes of the years of financial panic and business stagnation, from the effects of which we are about to recover.

Changes in standard of living, discoveries in sanitary science, new methods of transacting business, the development and differentiation of manufacturing processes and of labor-saving devices, the invention of electric light and electric power transmission, and the introduction of cable and electric railways have been instrumental in depriving many existing buildings of their usefulness and their adaptation to the purposes and requirements of our day.

The era of confidence in the soundness, stability, and integrity of the financial and business conditions upon which we have entered will revive and stimulate the spirits of enterprise and invention; these will create and develop new means of obtaining wealth and new avenues of

employment for the industrious and enterprising,—new opportunities for earning and accumulating surplus wealth. At first all will be mindful of the terrors of the panic and its causes, and therefore cautious and conservative, distrustful of the commercial value of the higher flights of enterprising inventors and enthusiastic promoters. But gradually distrust and caution will wear away, over-confidence and dauing will follow and increase, wholesome overproduction and accumulation of surplus will diminish, and malproduction will increase until another panic shall appear in the land.

But, for the present, millions of dollars are awaiting investment in commerce and manufactures. Ere long large sums will go towards the enlargement and development of existing enterprises, and more into new ventures and excursions into hitherto untrodden paths of industrial and commercial progress, the latter undoubtedly requiring new buildings adapted to novel requirements. Among all there will arise keen rivalry and competition to secure the best possible housing for carrying on the various enterprises, and every success in so doing will stimulate the efforts of competitors into eagerness for still better architectural results. As the earnings of the newly-invested funds will bring forth further supplies of capital, its owners will be carried by the general spirit of rivalry into further outlay upon better and better buildings. And so the struggle will continue, and increase in fierceness and intensity, and merchants, manufacturers, and capitalists will vie with one another in efforts to attain the highest and best results. Architecture and architects will be drawn into conflict, certainly to their own financial betterment; whether for the betterment of the general situation depends upon themselves. They will be carried along by the rush, and upon their success in so directing, limiting, and guiding the movements of the competing and struggling forces as to prevent waste and unnecessary risk of capital depends the status of American architecture and architects in the next half century.

Architecture and architects are man's creation and man's servants, and cannot avoid participation in every movement, for good or for ill, by which human society is swayed. As a man may combat evil hereditary tendencies, defy the influences of immoral surroundings, resist temptation to do evil, and develop into true and noble manhood, so also may the architect recognize evil tendencies and check them, note and recognize errors of judgment and avert them, turn funds from intended extravagance and malproduction into the channels of prudent and wholesome expenditure, and thus do his share toward prolonging the coming period of prosperity and minimizing the force and duration of the coming panic.

To be able to do this and to be an architect, a master-workman,

not only in a material sense, but in the control and guidance of the mental and emotional forces which make for the transmutation of the world's surplus wealth into architectural works, the architect not only must have acquired knowledge and command of the alphabet, grammar, syntax, and rhetoric of the many phases of his own art, science, and profession, but must have studied and mastered the history and philosophy of the development and progress of human society, of the rise and growth of science, invention, and discovery, and must have trained his mind to forecast the trend of coming scientific achievements and their probable practical applications to and effects upon human affairs.

No one architect can attain this standard, but each individual architect can keep it in view, and every one can try to come as near to it as his opportunities will permit. All can learn from each other; all can teach others, and acquire and impart knowledge in their intercourse with clients, contractors, artisans, and the general public. All can study the works and the literature of the past and present, and may, through the public and professional press, tell their contemporaries and their successors what they have learned through experience and study. Thus can the profession of architecture show itself worthy of its mission to be the conservator of the world's accumulated and invested surplus wealth.

During the approaching era of business prosperity innumerable architectural works will be undertaken. It lies with their designers whether or not they shall fulfil their intended immediate functions. It will be for their architects to ascertain whether these functions are likely to be temporary or enduring, and whether, therefore, the buildings shall be but temporary in their character, involving but little outlay, or permanent, and become the depositories of large volumes of the world's accumulated capital. If permanent structures are required, there is still the problem to be solved whether any preparation is to be made for the changes the future may bring forth, and what will be the character, extent, and trend of the expected developments and changes; and whether or not such preparations for future developments can be made without impairing the present value of the structure.

Upon the more or less successful solution of such problems as these will depend the status of the architect and his profession during the coming years. If they are correct, much mal-production and waste will be averted, and architecture will maintain its time-honored function as the receiver and guardian of the accumulated wealth of the ages, without failing to bear its part in the progress and work of the day, and in the competition and emulation of men in the struggle to surpass one another which lies at the foundation of human progress.

LABOR-SAVING MACHINERY THE SECRET OF CHEAP PRODUCTION.

By A. E. Outerbridge, Jr.

THERE is an evident impression in the minds of some employers of labor in this country at the present day that the only hope of successful competition with foreign countries, where labor is comparatively cheap, is to be found in a reduction of the wage-scale to approximate the low standard prevailing in those countries.

The purpose of this paper is to show the fallacy of this view, and to prove by argument and illustration that the true secret of success lies in an opposite direction. Careful observation and study of this important economic problem have convinced the writer that, wherever American manufacturers have, in the past, successfully competed in the markets of the world with similar products of foreign make, the success has been due to a fortuitous combination of improved labor-saving machinery operated by high-priced, intelligent mechanics, and that greater developments in the future should be sought in the same direction, not in reducing wages and lowering standards.

Certain fundamental principles have characterized American methods of manufacture, such as the adoption of interchangeability of parts and the designing of special machines to perform specific operations only, whereby the output of a factory is enormously increased, division of labor systematized, the costly work of finishing and adjusting minimized, and the highest development of skill, accuracy, and despatch acquired. These features have, perhaps, received most notable development in the fine art of watch-making by machinery in America, wherein the acme of perfection and economy is exhibited.

The system of concentration of labor in large factories for making watches in this country is the antithesis of the method of scattered manufacturing which prevailed for centuries in Europe, notably in Switzerland. M. Favre-Peret, who investigated this industry in the New England States some years ago, stated that the average production of 40,000 workmen in Switzerland was 40 watches per annum for each workman, while in America the average was 150 fine watches for each man employed.

In the operation of cutting and setting "pillars" by hand 30 per day represented a full day's labor, whereas, by the aid of the Elgin pillar-cutter, 2,000 pillars per day were produced by one operator. Again, in cutting the the teeth of certain wheels, one operative will

cut, with one machine, 1,200 wheels, having 96,000 teeth, per day, the cutting mills making 7,000 revolutions per minute.

By the aid of machinery one man can make 1,200 fine screws a day, some of which are so small that more than 100,000 are required to weigh a pound.

One of the finest pieces made is a "pallet-arbor," or pivotal bolt, which, for a small-sized watch, has a thread of 260 to the inch, weighs $\frac{1}{130000}$ of a pound, undergoes 25 operations, and costs but 2¼ cents. Measurements are gaged to $\frac{1}{25000}$ of an inch.

There are 80 separate operations upon a balance-wheel, 66 of them being drilling, threading, and countersinking holes; the drills revolve at a speed of 48,000 turns a minute, and one operator can drill upwards of 2,200 holes for the balance-wheels in a day. The balance-wheel, after being machined, weighs only 7 grains, and, when fitted with 16 gold screws, weighs 7.2 grains. It is customary in the large watch factories to start the manufacture of different grades of watches in lots of perhaps 1,000 of each kind at one time.*

The result of this marvelous development of labor-saving machinery and systematizing of methods of manufacture has been a reduction of the cost of excellent time-keepers to a point which enables every mechanic, farmer, and schoolboy to possess a reliable watch. American watches are exported, in competition with foreign watches, in enormous numbers to all parts of the world, and, notwithstanding the low prices, the business has yielded enormous profits.

By way of supplementing the foregoing record of development in delicate machinery it may be interesting to briefly refer to the economies which have resulted from the introduction of improved facilities for handling enormously heavy materials used in large engineering constructions. In place of the old-fashioned, cumbersome, slow-moving jib-cranes, which formerly were necessary adjuncts in every machine-shop, we now have high-speed overhead traveling cranes, operated, as a usual thing, by electric motors.

A comparatively small crane of this type (10 tons' capacity) was recently erected in a certain department of a large locomotive works, resulting immediately in a saving of about $100 a day in the work of the department.

In another branch of the same establishment two electric traveling cranes of much larger dimensions were installed about five years ago, dispensing with about 60 helpers formerly required to handle the work.

Recently the superintendent of the locomotive works of a promi-

* The above data are abstracted from the full and complete report upon watchmaking in Vol. II of the tenth census of the United States.

nent railway company, after a thorough investigation, estimated that the introduction of two 50-ton electric traveling cranes in the shops under his charge would effect a saving of more than $30,000 a year, and, upon the strength of this report, which was practically equivalent to a guarantee on his part to that effect, two 50-ton traveling cranes were ordered, and are now in course of construction.

Assuming that a modern passenger engine weighs about 130,000 pounds and costs about $8000, the cost per pound is less than 6¼ cents. Many readers will remember when the cost of the raw material (chiefly iron and steel) entering into the construction of an engine, was more than this.

The modern flat turret lathe for quickly and accurately cutting screws and bolts from round, square, hexagonal, or other commercial forms of bars without the necessity of preliminary forging to approximate shapes is a notable American labor-saving invention, which, in the hands of an active and intelligent operator, has capacity for large output at low cost. Among the minor economies introduced in American machine shops, the system of having a separate department for the manufacture, care, inspection, and storage of cutting tools, from which they are delivered to the users only on checks, which serve as receipts to identify the person at fault in case of their loss, breakage, or misuse, has been of so pronounced benefit that it has been almost universally adopted. Automatic tool-grinding machines are now provided, by which rough-forged tools are quickly and accurately ground by unskilled labor to standard forms which experiment and experience have proved to be best adapted for the special work they are designed to perform. The quality of work is improved, the output is increased and the cost is reduced by the system.

Foreign engineers and mechanics who have visited American workshops have rarely failed to express astonishment and admiration at the perfection of labor-saving appliances everywhere visible. A report on "America's Industrial Progress" by M. Levasseur (member of the French Institute) in the *Revue Politique et Parlementaire*, attributes the supremacy of American manufactures to the wise economy of "unceasingly replacing out-of-date machines by new and improved types." Several illustrations from personal observation are given, and it is stated that, in one of the largest and oldest establishments of the kind in the United States, not a single ancient machine tool was found working.

Heretofore American manufacturers have been so busily employed in supplying the home demand for their products that the incursions into foreign markets have been only spasmodic, but the time has now come when a concerted effort should, and probably will,

be made to exploit systematically the opportunities which have presented themselves, almost unsought, to extend trade abroad in all directions. During the dull times recently some important efforts have indeed been made in this direction, with encouraging result, and, since the recent visit of a distinguished foreign ambassador, Li Hung Chang, some proposals have emanated from that source which are destined to prove of incalculable value to certain American industries. More specific information regarding these facts, which have come to the writer's knowledge, can not be given at present, but will doubtless become generally known in a short time.

It cannot be doubted that the policy which has generally prevailed in this country of employing intelligent mechanics at high wages has stimulated the invention of labor-saving machinery and decreased cost of manufacture; therefore, the proposal at this date to lower the standard of wages in order to compete with foreign manufacturers is a short-sighted and narrow-minded proposition, which would certainly defeat the object in view and ultimately lead to disaster.

Statistics prove that a reduction in wages is always followed by an immediate reduction in consumption, not only of so-called "luxuries," but of all the multifarious manufactures of the country; for the wage-earners are the largest consumers.

Increase of wages and increase of consumption go hand-in-hand, and a period of high wages is synonymous with a period of great prosperity.

A fallacious argument is often advanced to show that high wages are the effect, and not in any respect the cause, of prosperity, but enlightened manufacturers are beginning to take a broader view of the subject, and some of them have already proved, by actual trials, the truth of the propositions here advanced. A few specific instances will be given of these interesting tests.

The president of a large manufacturing company engaged in making a special machine (the "Linotype" type-setting machine), the labor cost of which is said to amount to nine-tenths of the total cost, made the following remarkable statement a few months ago.

His company, he said, has a factory in Brooklyn, and, until recently, had an interest in a factory in Germany, where identically the same machine was built, largely by the same fixtures, tools, and system of manufacture.

Labor in the German factory was about forty per cent. cheaper than in Brooklyn, but the Brooklyn factory produced the machines at a lower cost in dollars and cents.

Other manufacturers have had similar experiences, and M. Mandon, the French engineer, who recently visited this country, stated*

* See *American Machinist*, May 21, 1896.

that exact duplicates of well-known American tools had been made in Paris, but could not be sold there as cheaply as the American tools could be, notwithstanding cost of carriage and the French import duty.

The scientific piece-work system, sometimes called the "differential system," devised by Mr. Fred. W. Taylor and put into practical operation by him at the Midvale Steel works, is a good illustration of the economy of high wages.

This method of remuneration differs radically from the ordinary piece-work system of payment; it makes each workman's interest the same as that of his employer; it pays a premium for high efficiency, and soon convinces each man that it is for his permanent advantage to turn out each day the best quality and maximum quantity of work.

Briefly stated, the differential system, which has had a test of several years, consists in paying a higher rate *per piece* for a greater amount of work done, without imperfection, within a given time.

The following illustration will show the economy of high wages under the differential-rate system, as applied to turning certain steel forgings, of which many thousands were made.

COST OF PRODUCTION PER LATHE PER DAY.

Ordinary Piece-Work System		*Differential-Rate System*	
Man's wages	$2.50	Man's wages	$ 3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	$5.87	Total cost per pay	$6.87
5 pieces produced.		10 pieces produced.	
Cost per piece	$1.17	Cost per piece	$0.69

These represent actual results obtained in daily work, the difference being due mainly to the differential rate.

This system does not spare the tools, which are run at a high rate, under heavy feed; and, since its introduction, the views of progressive manufacturers regarding the economical use of machine tools have materially changed.

Formerly old tools were venerated and carefully preserved as long as they could be used. Now the aim seems to be to obtain the full life-service in the shortest possible time, and then to consign the tool to the scrap-heap. In this way tools are worn out long before they have become obsolete in design, "soldiering" on the part of operatives is effectually eliminated, the output is increased, and cost of production is decreased in an astonishing ratio.

Recently a practical illustration of this subject, from the operatives' standpoint, came to the writer's knowledge.

A skilled lathe-hand, who had been employed in one establishment for several years on one kind of work, went to another shop, where he

was offered twenty-five per cent. more pay per piece for precisely the same job; he soon found that, owing to the continued use of an antiquated lathe in this establishment, and consequent smaller output, he was unable to make as high wages as he did at the former place of employment, although far more care and attention on his part were required to avoid errors in sizes, all of the pieces being fitted to standard gages.

Mr. Hiram S. Maxim, the well-known inventor, established extensive machine shops in England a few years ago, and found that English machine tools were old-fashioned and English operatives inefficient. He thus describes his experiences: "When I first came to England, wishing to buy some lathes, I examined a large number by different manufacturers, and was surprised to find how old-fashioned they were. . . So, when I had to equip some very large factories, I found it to the advantage of my companies to purchase the greater part of the tools from American makers." Having obtained American tools, Mr. Maxim then encountered a serious difficulty in securing competent operatives, and, furthermore, he found that American automatic machines, several of which are commonly placed in the charge of one workman in the United States, must be run singly in England. "This is due to the influence of the trade unions. These associations control the men in England to such an extent that they dictate how many machines the men shall run, and, except in special cases, they refuse to allow one man to take charge of more than a single piece."

Finally, as a result of a strike at the Maxim-Nordenfeldt gun factories, previous to which many of the union men not only objected to work more than one milling machine, but wanted the company to agree not to allow any non-union men to operate more than one, unskilled men were placed in charge of the milling machines, and in a short time one such man was able to operate four machines where a union man had run only one.

These illustrations might be extended and elaborated, but, even when thus briefly stated, they serve to emphasize the general statement that labor-saving machinery, while, in one sense, a competitor of hand labor, is, in another and larger sense, its most efficient handmaiden, or help-meet; not only has labor-saving machinery decreased cost to the consumer, but it has increased wages of operatives and decreased manual toil. It has been the means of substituting intelligence for brute strength, and has, in all respects, proved the friend of labor.

In a former paper, in this magazine,—one of a series,—the writer said: "The introduction of labor-saving machinery has enormously increased the output for each workman, and this introduces a new element into the ethics of the question of wages, and also into the

practical question of cost. If it can be shown that a skilled workman, at a slight increase of labor and attention, can enormously increase the output of a machine, he should be encouraged to make the effort by an increase of pay; an increase of output must logically and necessarily involve a corresponding and fair increase in wages.

"Hence increase of output necessitates increase of wages, and, in a properly-conducted business, this increase of wages, following increased output, must mean increased profit. This is a profit-sharing scheme to which there can be no practical objection."

The conclusion to which the arguments and illustrations here given lead are:

I. The true policy of the employer of labor is to encourage the brightest and most inventive workmen by liberality in the wage-scale, and to stimulate the improvement of all mechanical methods and appliances in order to continually increase the output for each man and each machine in his establishment.

II. The true policy of the employee is to use his best powers of mind and body to obtain from the improved machines the maximum output, with minimum errors, and thus to secure maximum wages.

When these policies shall have become universal principles, actuating employers and employees alike, there will be no reason why this great country should not, in accordance with Mr. Atkinson's forecast, gain the paramount control of the commerce of the world.

This is surely a prize worth striving for, and can be gained only through the harmonious and intelligent coöperation of capital and labor.

THE RISE OF THE YOUNG GIANT, COMPRESSED AIR.

By Curtis W. Shields.

GENERAL HERMAN HAUPT, writing in THE ENGINEERING MAGAZINE in August, 1892, used the significant sentence: "The fact that pneumatic motors, after a successful demonstration of their superiority, have been largely overlooked seems inexplicable." This comment was made in immediate connection with the subject of motors for street-car propulsion, but General Haupt had no limited conception of the certain future for compressed air.

The importance he attached to it as one of the great rising agents in power application and power transmission is most clearly demonstrated by his criticism of the proposed and since completed electrical-power station at Niagara. The late Franklin L. Pope, in THE ENGINEERING MAGAZINE for December, 1895, quotes him thus: "General Haupt, however, ... boldly takes the ground that the attempted employment of electricity for the distribution of power from Niagara is an engineering mistake, and contends that the only economical and commercially-feasible plan is that which depends upon the use of compressed air."

Such faith was remarkable, but strongly founded. Rapidly making its way under the trying, but infallible, test of competition, compressed air has risen above the need of any apologist, and stands now as one of the most efficient agents in putting our shops, our industries, and our manufactures on that basis of economy and efficiency which is the essential forerunner of prosperity. But, while one of the newer agencies in its effective application, it is far from new historically.

Authentic records antedating 250 B. C. show conclusively that Ctesibus of Alexandria accomplished the harnessing of that omnipresent and irresistibly powerful element, the air, and among other uses applied it to a kind of air-gun which projected an arrow a considerable distance with great force and accuracy. At first thought it appears strange that greater progress has not been made in a science of which at least something was known so many centuries ago, and the possibilities of which have been continuously impressed upon each individual (at the rate of 14.7 pounds to the square inch) ever since.

There has been, of course, a gradual progress both in the application and in the generation of compressed air for centuries, but it made but little real headway prior to its adoption by Prof. Colladon, of Gen-

eva, as a motive power for operating the machine-drills in the famous Mont Cenis tunnel. In America the first practical use of compressed air on a large scale was at the Hoosac tunnel. The compressor for this work (Fig. 1) was built just prior to 1866 from designs of Mr. Jno. W. Brooks, chairman of the Massachusetts State Commission, and Mr. Thos. Doane, chief engineer for the tunnel construction. After the completion of this tunnel, this compressor was moved to Proctor, Vermont, where it has been in use ever since, compressing air to a pressure of about three atmospheres to the square inch. This air is used for operating channeling machines and rock drills of modern construction, which have revolutionized the method of quarrying.

In the arrow-throwing gun of Ctesibus, the ancient air mattress (Fig. 2), and the compressor used at the Mont Cenis tunnel (Fig. 3) we find the prototypes of the present pneumatic dynamite gun (Fig. 4) now in use by the Cubans; the sleeping-car equipped with pneumatic chair-seats, pillows, and mattresses inflated by compressed air supplied from the air-brake pump on the engine; and the cross-compound condensing Corliss compressor plant (Fig. 5), now used in

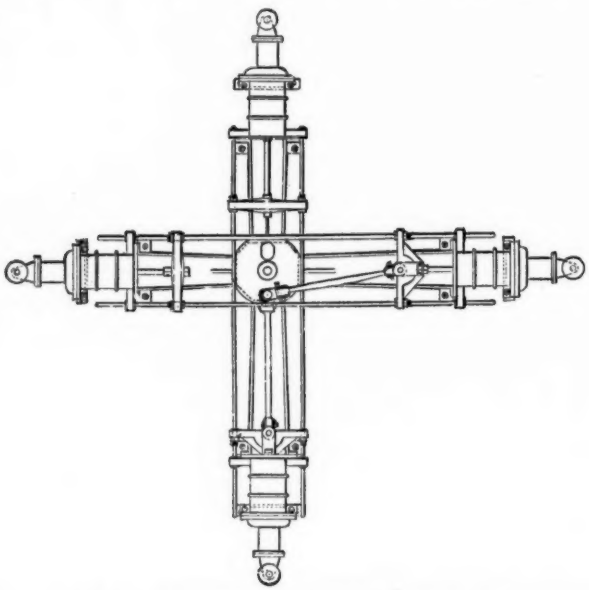


FIG. 1. THE COMPRESSOR USED AT THE HOOSAC TUNNEL.

FIG. 2. AN ANCIENT AIR-MATTRESS.

operating the machinery employed in excavating the colossal reservoirs at Jerome Park, which are designed to supply potable water to the city of New York. Again the air-lift pump of to-day, for deep wells, shows the evolution of Hero's Fountain, a pneumatic experiment familiar to all students of natural philosophy. The pneumatic tube system for the conveyance of parcels or mail matter, such as is shortly to be installed to connect the New York and Brooklyn post offices *via* the Brooklyn bridge and the Pennsylvania & Reading terminals with the Philadelphia post office, had its origin nearly two centuries ago in the fertile brain of Dr. Denys Papin, of Blois, France.

In 1869 George Westinghouse produced his first air brake, the de-

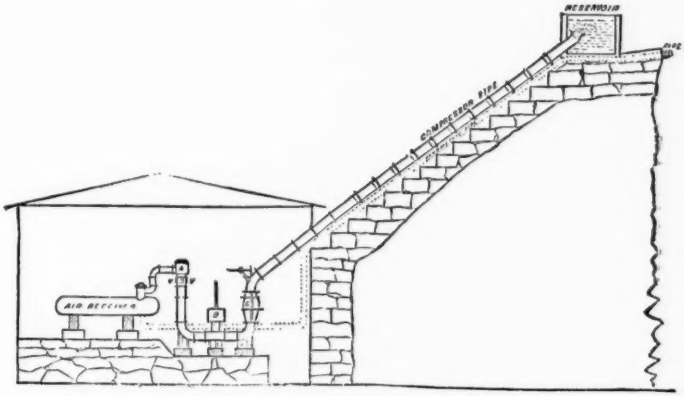
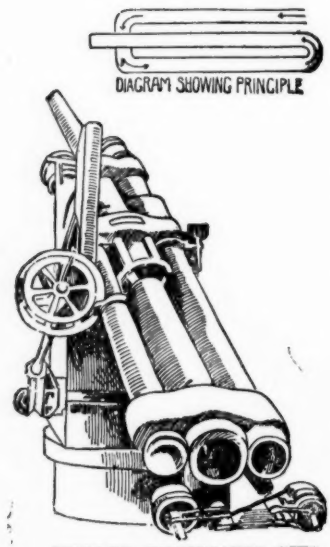


FIG. 3. COMPRESSOR USED AT THE MT. CENIS TUNNEL.



DUDLEY PNEUMATIC GUN.
FIG. 4.

velopment of which, known as the "automatic brake," has materially reduced the danger of accident in railroad travel. It was not until the latter part of 1887, however, that he succeeded in constructing the present quick-acting, automatic brake, which operates under all conditions of practical railway service. Next in importance to the air brake in railway service is the operating of switches and semaphore signals. Here again compressed air is the factor that plays the all-important part. On the Harlem division of the New York Central & Hudson River Railroad compressed air for these purposes is carried through pipes from Mott Haven (One Hundred and Thirty-eighth street) to White Plains, N. Y.,—a distance of seventeen miles. Another branch pipe to Woodlawn—a distance of six miles—conveys air to move an ordinary

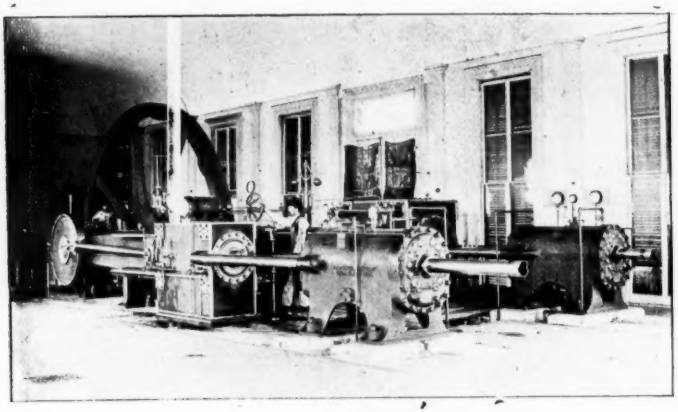


FIG. 5. A MODERN AIR-COMPRESSING PLANT.

engine which drives the dynamo supplying the electric current necessary for this signal system. Indeed, railway work seems to excel any other branch in the diversity of uses found for compressed air. It serves to signal the engineer, to ring the bell, to sand the track, and even to dust the cushions, clean the hangings, and raise the water in the lavatories of the sleeping-car; and in the shops it lends itself with equal readiness to heavier duties.

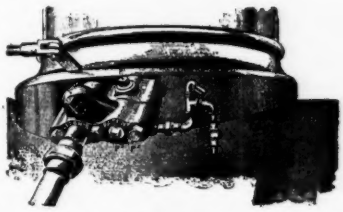


FIG. 6. PNEUMATIC TRACK-SANDER.

A sand-papering machine made up of a framework on which is mounted a disc covered with sand paper revolving at a very high rate of speed does the work of six good carpenters, and, operated by one man, finishes the surface of a baggage car, making it ready for the painters, in fourteen hours.

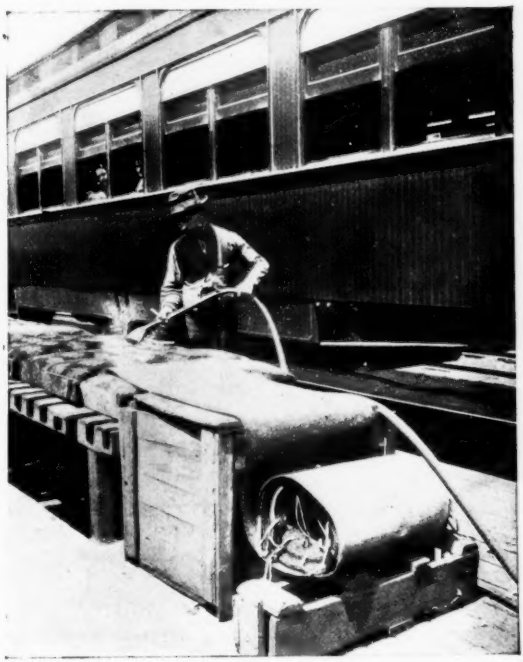


FIG. 7. CLEANING CAR CUSHIONS WITH AIR.

A portable pneumatic saw for cutting off the ends of the boards on freight-car roofs trims off both sides of a thirty-four-foot car in six minutes. Likewise a machine for planing floors or decks of ships is driven by a rotary air motor mounted on what seems at first glance to be an ordi-

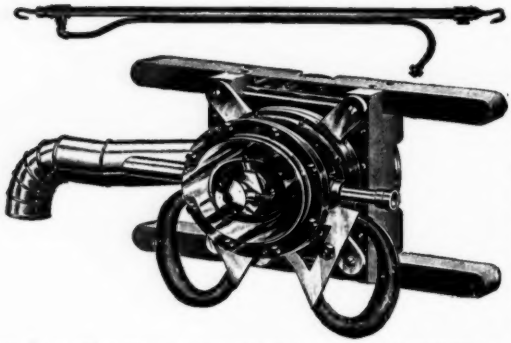


FIG. 8. SAND PAPERING MACHING OPERATED BY COMPRESSED AIR.

nary lawn-mower. The round-house turn-tables, for shifting locomotives, are in many cases actuated by air power. Fig. 14 shows the air cylinder located at the base of the pit and operated by allowing the air to enter either end, as may be desired. The piston forces a rack along, thus turning a pinion that swings the turn-table to the desired position.

A steel ditcher, scraper, and excavator operated by compressed air is now used for grading road-beds and making ditches for draining the same. This ditcher is composed of a heavy steel frame platform car forty-six feet long, on which is mounted a derrick having a swing of fourteen feet. The hoisting and lowering apparatus is worked from an air cylinder attached beneath the car. This derrick and hoisting attachment is used for adjusting and keeping at a proper height all the tools for ploughing, excavating, leveling, ditching, or grading, as well as for loading and unloading all tools and machinery from the car.

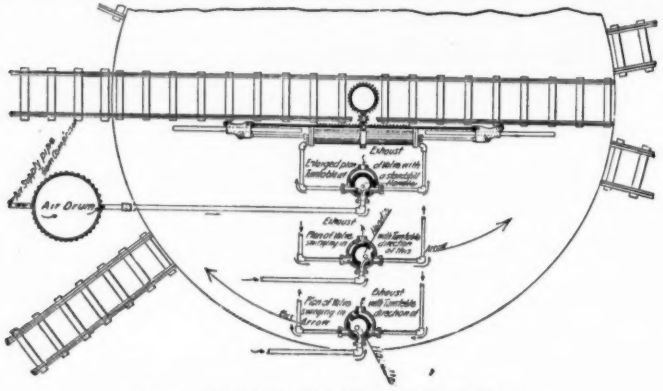


FIG. 9. PNEUMATICALLY OPERATED TURN-TABLE.

The air-using appliances are all operated by a man stationed at the base of the derrick, by means of three four-way cocks. The plough, proceeding at the rate of four miles per hour, will cut a furrow twenty-nine inches deep by thirty-six inches wide. This outfit (Fig. 10), will perform work in one day at a cost of less than $20 which would cost not less than $500 by former methods.

All kinds of painting where large surfaces have to be covered, as is the case with freight cars, buildings, bridges, and ships, may be done by compressed air, which blows on a spray of paint and penetrates interstices much better than the hand can do it. Much time is saved, and the necessity of costly brushes, skilled labor, and scaffolding is done away with.

FIG. 10. PNEUMATIC DITCHING AND GRADING MACHINE.

At the present time the use of compressed air for street-cars is exciting the greatest attention. Trials of these cars under actual working conditions are now in progress both on surface and elevated tracks in New York, Chicago, and Washington. The compressed-air motor-car shown in Fig. 11 has been in successful operation on One Hundred and Twenty-fifth street, New York city, for several months, making in daily service seventeen miles without recharging, under the identical conditions met by trolley or cable service, and has conclusively demonstrated its ability to meet all requirements. In fact, the makers of these cars guarantee that a line equipped with them can be maintained and operated at a cost per car-mile not exceeding that re-

FIG. 11. COMPRESSED-AIR STREET CAR, IN SERVICE IN NEW YORK.

quired for overhead trolley service under precisely the same conditions. Economy of operation is the crucial test from the standpoint of the traction companies. The features that appeal most to the passengers and the public in general are the doing away with poles, overhead wires, and the continual excavating for cables, pipes, or conduits. No fatal accidents from live wires; no obstructing the efforts of the fire department in moments of danger to life or property; no possibility of stalling on railroad crossings in front of approaching trains; no obstructing of the running of the cars by tampering with the source or conductor of power during riots or strikes; and no electrolysis of water- and gas-pipes by escaping currents.

Compressed air at high pressure (2,000 pounds) is stored in Mannesmann steel bottles located under the cars. There is no danger connected with the use of this tremendous pressure, for the method of making these reservoirs and the composition of the metal prevent all possibility of injury to passengers, even if an explosion should happen. At a recent test to destruction by hydraulic pressure one of these bottles broke at a pressure of 5,760 pounds to the square inch. A crack or split about 2½ feet long opened on one side, but not even the smallest particle of the metal flew, and a crowd of interested spectators standing from three to ten feet away were entirely unharmed. As the greatest pressure is put on these reservoirs at the instant the charging is finished, and as the pressure is gradually re-

duced as the car goes on its journey, there seems to be little likelihood of even a harmless explosion while passengers are in the car.

In mining operations compressed air has long been used for running pumps, drills, coal-cutters, and locomotives. In coal mines which are troubled with gases, lumber yards, powder mills, and the great cotton wharves and warehouses of the south, the compressed-air locomotive has a special field of usefulness on account of the necessity for extra precautions against the risk of fire. A locomotive of this type (Fig. 12), having a capacity of 580 cubic feet, can be charged in one and one-half minutes to a pressure of 600 pounds to the square inch.

In mines the exhaust air from the various machines serves a useful purpose in ventilating and cooling the workings.

It was largely owing to the use of compressed air as a motive power for excavating-machinery that so gigantic an engineering feat as the Chicago drainage canal was made possible at a reasonable cost.

This tremendous undertaking involved the excavating of a channel 160 feet wide and 35 feet deep, containing 12,071,668 cubic yards of solid rock. On this work no less than fifteen air-compressors were employed.

It impressed one with feeling that can best be described as *uncanny* to see dozens of powerful drills, huge channelers, pumps, and hoists handling large quantities of material with no visible indication of a motive power. The quantities of exhaust steam usually so much in evidence were here almost entirely absent, giving an air of mystery to the whole operation ; and it seemed to the uninitiated observer as if no actual work was being done.

One of the greatest strides toward the goal of perfection was made when it was determined that compressed air could be advantageously used in the building of large high-level canal locks. This simple contrivance, which is designed for installation at Lockport, N. Y., will, it is estimated, take the place of the sixteen locks now used at Cohoes, and at one operation boats will be raised to a height to which they could previously be raised only by sixteen locks. The immense saving in

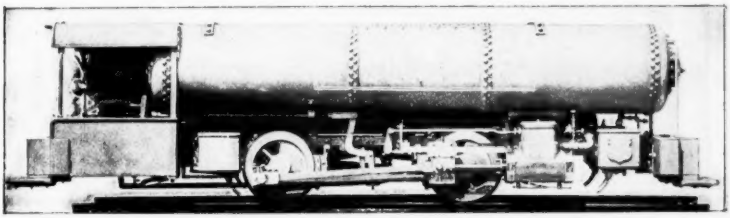


FIG. 12. DOUBLE-TANK COMPRESSED-AIR LOCOMOTIVE.

cost of construction and time of operation can be readily appreciated.

The principle on which these locks work may be best described by the following simple experiment. Take two tumblers and fasten their bottoms together; you will then have a representation of one section of these locks. Partially fill the upper tumbler with water, and place both in a basin or tank of water with the empty tumbler open end downward. With a tube blow air into the lower tumbler until it almost rises clear of the water. A second pair of tumblers similarly arranged will represent the other section of the air lock. Connect the air spaces of the two bottom tumblers by means of a tube, and, thus balanced upon the compressed air, both sets of tumblers rise or fall, and air is made to flow from one tumbler to the other through the connecting tube or pipe.

This principle has also been applied to dry docks for repairing vessels, and has many advantages over the ordinary type of off shore docks now in use.

But for compressed air, it would be almost, if not quite, impossible to obtain suitable foundations for the mammoth sky-scraping structures which stand out so prominently in lower New York. In this foundation work, both for buildings and piers for bridges, caissons have to be sunk gradually, as the excavation progresses. Compressed air is used to keep the working chamber at the bottom from

FIG. 13. INTERIOR OF A CAISSON, 74 FEET BELOW WATER-LEVEL.

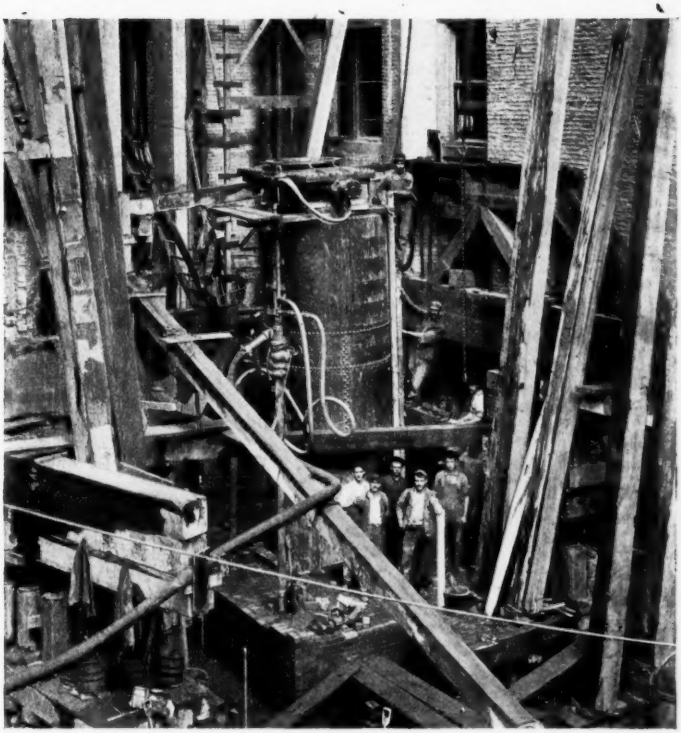


FIG. 14. COMPRESSED AIR IN FOUNDATION WORK. SINKING A CAISSON FOR THE FOUNDATION OF THE AMERICAN SURETY BUILDING, NEW YORK CITY.

being filled by the water and soft earth or mud that otherwise would prevent the men from working. It also operates the rock drills, and serves to ventilate the caisson work. With proper precautions a perfectly healthy man can work under an air pressure of seventy-five pounds per square inch, though forty pounds is rarely exceeded in ordinary work.

In wrecking operations compressed air is employed to force out the water from numerous barrels or bags which are attached by divers to a sunken vessel, thereby furnishing the buoyancy necessary to bring the vessel to the surface.

The use of compressed air on board the United States monitor "Terror," for turning the turrets, working the guns and ammuni-

FIG. 15. COMPRESSED AIR IN BRIDGE WORK. BUILDING PIER OF CANTILEVER BRIDGE AT THE NEEDLES, CAL., ON A CAISSON SUNK 64 FEET BELOW WATER LEVEL.

tion hoists, and operating the steering gear, makes this floating engine of destruction one of the most notable vessels in our navy. (Fig. 16.)

The whole stone trade, from the first operation of quarrying to the finished carvings, has been revolutionized by the use of compressed air. In fact, the introduction of air-operated machinery is about the only marked improvement in handling stone that has been brought forward since the stone age. The channeling machine cuts out blocks in the hard unyielding masses of stone in much the same manner as we cut squares of cheese with a knife. This process obviates the use and expense of explosives and the enormous waste of material, inseparable from blasting. All the finest carvings, tracery, and lettering on both building and monumental work is done by means of a small pneumatic engine weighing about two pounds, held in the hands of the workman. This machine comprises a cylinder or shell six inches long, which contains a solid piston or hammer reciprocating very rapidly and striking the end of the chisel about ten thousand blows per minute. As a man cannot swing a heavy

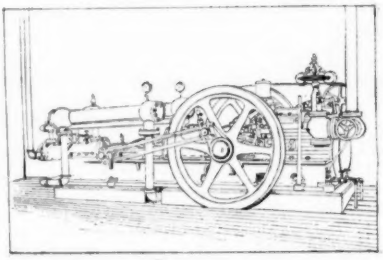


FIG. 16. AIR-COMPRESSOR PLANT ON THE U. S. MONITOR TERROR.

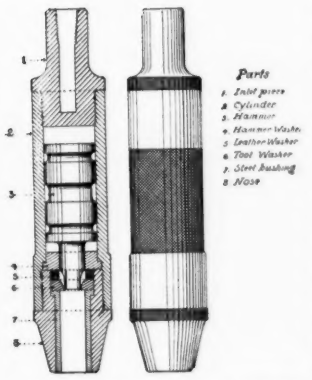


FIG. 17. PNEUMATIC STONE-CARVING TOOL.

hammer continuously more than thirty times per minute, one can hardly imagine the great increase in the capacity of a skilled artisan equipped with one of these handy little tools (Fig. 17).

In nearly all manufacturing and mercantile pursuits more or less lifting of goods is necessary. For hoisting purposes compressed air is unrivalled, both in speed and cost. Sufficient air can be obtained at an expense of 3½ cents (for compressing) to lift a weight of 2,500 pounds four feet *one hundred times*. Such a hoist (Fig. 18) is a very simple contrivance, being nothing but a cylinder, made of a section of pipe closed at both sides and fitted with a piston whose rod, terminating in a hook, projects through a stuffing box in the bottom cover of the hoist. Air is admitted through a flexible-hose connection to the lower side of the piston, and lifts whatever weight may be attached to the hook. By suspending these hoists from an overhead track, goods can be transported to any part of the establishment. This method has an advantage not possessed by an overhead traveling crane,—*viz.*, that it can extend its field of usefulness

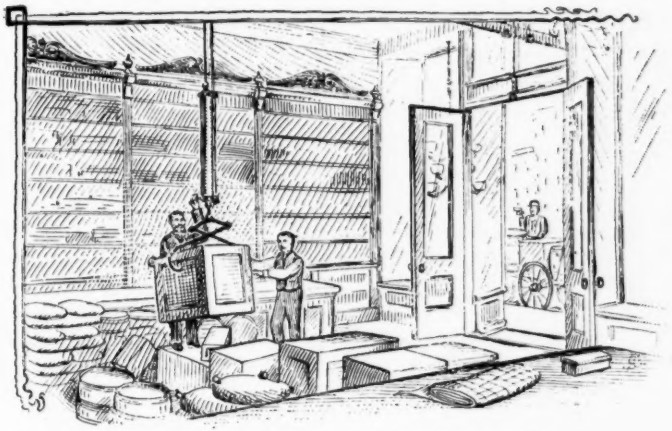


FIG. 18. COMPRESSED-AIR HOIST IN A WAREHOUSE.

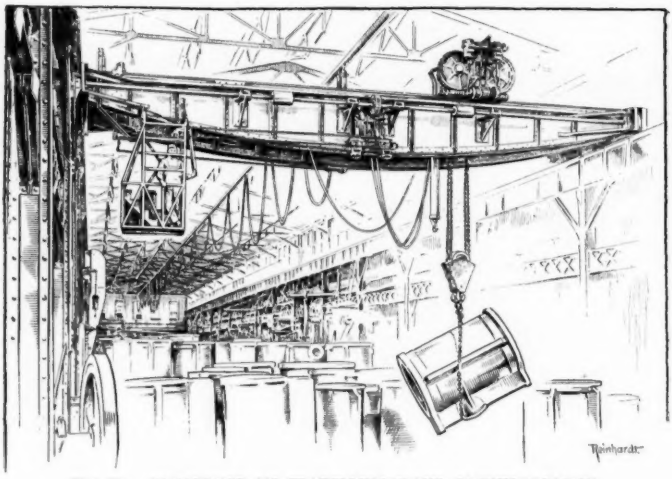


FIG. 19. COMPRESSED-AIR TRAVELLING CRANE, 20 TONS CAPACITY.

beyond the confines of the shop in which it is located, and can follow the track and transport its load to any desired point.

In order to do this, hose connections are used similar to those employed on trains for coupling the air-brake pipes between the cars. A hoist is made, the pipe disconnected, and the load transported. In stores heavy boxes, barrels, etc., can be readily picked up by an air hoist and loaded upon a wagon by one man in less time than it could be done by several men using less modern methods. By an actual test a weight of one ton was lifted and transported a given distance in one ninth the time required to operate an ordinary differential-chain hoist of the most improved type.

Where the head-room will not permit the use of the pendant direct-acting hoist, a rotary air motor is attached to a differential hoist in place of the usual endless chain.

Large traveling cranes actuated by compressed air are used to great advantage in foundries where the dust and heat are so detrimental to electric motors as to render them inefficient and a continual source of annoyance through stoppage or breakdowns (Fig. 19).

Portable pneumatic riveters have supplanted both hand and hydraulic work, and not only operate more economically, but, on account of their light weight, can be handled more quickly; moreover, the number of rivets driven per day is largely increased (Fig. 20).

In confined spaces where it is impossible to drive rivets in any

other way than by hand it frequently is a problem to determine how to back up or "hold on" a rivet while it is being hammered into place. The little air ram (Fig. 21) comes to the rescue, and provides an elastic wedge, or backing, that enables the men to speedily drive the rivet.

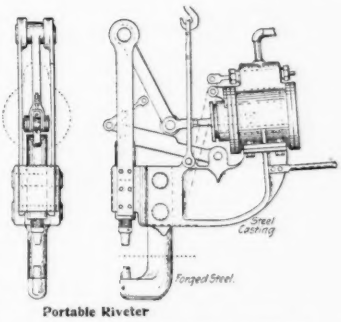


FIG. 20. PNEUMATIC RIVET DRIVER.

In the machine shop, or on work where the holes have to be drilled and where it is impracticable to use an ordinary drilling-machine, the pneumatic breast drill (Fig. 22) puts in the required hole while held in the hands of a workman. This little tool, weighing 18 pounds, with 80 pounds of air pressure will drill a $\frac{5}{16}$ inch hole through cast iron one inch thick in one minute. It is especially useful for centering and counter-sinking lathe work, drilling holes for tap bolts and screws, or grinding-in valves.

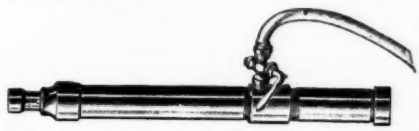


FIG. 21. RIVET HOLDER-ON.

The reamer (Fig. 23) has revolutionized the methods of reaming the rivet-holes and the tapping and insertion of stay-bolts in boilers.

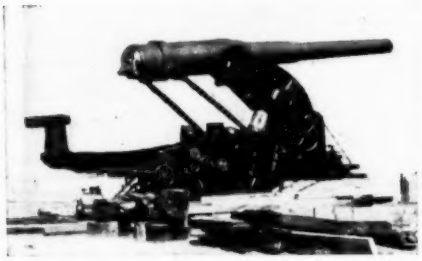
FIG. 22. AIR-DRIVEN BREAST-DRILL.

In the use of heavy lathes, planers, or other large shop tools much annoyance and loss of time results from the difficulty experienced in shifting belts. A compressed-air belt-shifter designed by some ingenious mechanic made this trouble a thing of the past. Many machine shops now use compressed air for so many important operations that a stoppage or breakdown of the air machinery is a very much more serious matter than if the shop engine were to be suddenly placed *hors du combat*. In

the latter event the major portion of such a shop would be driven by compressed-air engines mounted on small trucks, as is often the case in overtime or Sunday work. But, if the compressed air supply should cease, the hoists and other air-using apparatus would be inoperative, and, as other means of performing this duty have been discarded, the shop would have to shut down.

FIG. 23. AIR DRILL AND REAMER.

In foundries compressed air operates hoists and traveling cranes; molding machines which, in the hands of an unskilled laborer, turn out more and better work than could an expert molder at double the wages; sand-blast machines, by means of which compressed air blows a jet of sharp sand against the castings as they come fresh from the molds, and thoroughly cleans every particle of sand, scale, or core from the casting, leaving it with a bright grey polish that is impossible of imitation by hand. These machines use the sand over and over again, automatically, until every particle of it has been used up or ground to powder. The operator merely has to direct the hose nozzle against the core, whereupon sand sticking to the casting and all the dirt and dust are drawn down through grate-bars in the floor by an exhaust-fan system. The core irons fall into a bin, or pocket, from which they are readily removed for use again. The fine dust is blown outside; and the sand is sifted or screened, and carried up overhead, whence it is fed by gravity back into the sand-blast machine, ready for use.



DISAPPEARING GUN, PNEUMATIC CARRIAGE.

The time-honored screw-press for copying letters has been supplanted by a compressed-air ram, which presses the copying-books much more forcibly and quickly than can the hand, all the muscular effort required

being that incident to the turning of a small valve. Office-buildings are now being fitted with a compressed-air supply for the convenience of tenants. The Havemeyer building in New York has air pipes led up through the pipe-shaft with branches at each floor, and the convenience of an air-supply for dusting and cooling the offices influences prospective tenants when seeking a new location.

Few of us know that the modest bundle of kindling wood purchased at the corner-grocery is pressed into its small compass ready for the binding-twine which holds it together by a compressed-air ram. Dozens of these presses are located in long rows on the sides of large tables, upon which piles of the small sticks are heaped. Girls with deft fingers quickly gather the wood into the compress, and, while the air pressure is holding the bits of wood closely together, the girdle of twine is slipped on.

Of the smaller adaptations of this convenient agency, as in bicycle motors, and of the uses which are not properly in the field of power, as the preserving and refrigerating of perishable products, it is not necessary to speak here. It is desirable, however, to impress the point that compressed air and electricity work in the utmost harmony, and are not the competitors that they are commonly supposed to be. Usually each performs duty for which it is so preëminently fitted that there can be no question of competition. Compressed air cannot be used for lighting; neither can electricity be used to advantage to operate a brake on a train. They are both means of power transmission, but, when it comes to the actual application of the power, each has its own fields. One great advantage of compressed air is that it is entirely harmless in the hands of inexperienced persons. No special knowledge or training is necessary to enable the ordinary mechanic to operate compressed-air machinery. As the artisans in the various trades become more and better acquainted with the ease with which air can be applied to their work, the inventive genius which is so thoroughly a part of the American workman's stock in trade will find numerous applications for this most tractable of servants, and we can expect to learn at no distant date that a company such as exists already in Paris has started to furnish compressed air for domestic use here. No doubt, before the end of the next decade, we shall have our refrigerators cooled by compressed air, and the thrifty housewife will run the sewing machine, rock the cradle, and dust the furniture from the same hose-pipe.

THE PRESENT AND FUTURE OF AMERICAN RAILROADS.

By Thomas F. Woodlock.

THE most important manufacturing industry in this country is that of railroading. Out of labor and material the railroads manufacture transportation, which they sell to the public. The value of their product is far in excess of one billion dollars annually, and the plant from which this is produced now comprises (exclusive of street railroads) 180,000 miles of railroad, or about one-half of the railroad mileage of the world. The manufacture of transportation gives work directly to about one million men, and at least three millions to four millions are directly dependent upon the railroads for support. The wages bill of our roads probably approaches half a billion dollars annually, in addition to which they spend about two hundred and fifty million dollars for material, such as fuel, steel rails, lumber, etc. There is no industry in the country that approaches transportation in importance, and no interest exceeds it save that of agriculture.

We are apparently on the threshold of one of those periods of activity, recovery, progress, and expansion that men speak of afterwards as "good times," though they sometimes fail to admit the existence of the "good times" while they last. Assuming this, it is surely important to find out where stands our great railroad estate, and what it has to expect from the future which looms so bright for every one. Let us, as a preliminary, consider a few facts of history.

Last year (1895) 179,000 miles of road took in from the public, in one shape or another, $1,093,139,605 as gross earnings. This resolves itself into $6,101 per mile of main track. The cost of doing this business, including taxes, absorbed $769,943,151, or $4,297 per mile, leaving the net earnings $323,196,454, or $1,804 per mile. If we assume that operating expenses include everything required to conduct transportation and fully maintain plant, these net earnings represent the profit accruing to our railroad estate, from its own business,—that is, strictly railroad business.

The sum of $323,196,454 is equivalent to 6 per cent. interest on a sum of $5,386,609,100, which, in turn, is equivalent to a capitalization of almost exactly $30,100 per mile of main track, fully equipped and with terminals. The nominal capitalization of the railroads, however, at the end of 1895 was $60,835 per mile, on which last year

net earnings represented less than 3 per cent. It may be proper to say that, while our railroad system may have originally cost a good deal less than $60,000 per mile to build, with equipment, terminals, etc., complete, its actual value to-day, if measured by no other standard than the cost of duplication, is decidedly greater than $30,000 per mile. Indeed, much of it simply could not be duplicated; for example, the terminal facilities owned in such cities as Philadelphia, Chicago, Boston, St. Louis, St. Paul, Kansas City, and the other great cities in this country, where real estate is sold by the foot and almost by the inch.

However, we are considering facts as we find them. We find that in thirteen years—to go no further back—gross earnings per mile of road have fallen from $7,461 to $6,101, and net earnings from $2,702 to $1,804. In this period the railroad system of this country has grown from about 107,000 miles to 179,000 miles of main track. The decrease in gross earnings per mile in this period is $1,360, of which $894 is accounted for in freight earnings and the balance in passengers. The net loss is $898 per mile, as the saving in operating expenses was only $462 per mile. Thirteen years ago, however, the number of tons carried for each mile of road was 3,744, whereas last year it was 4,263, so that 4,263 tons last year produced $894 less gross revenue per mile than did 3,744 tons thirteen years ago. Where a ton of freight produced $1 thirteen years ago, it produced only 68 cents last year, other things being equal. Putting it in another way, where the railroads hauled a ton of freight 81 miles for $1 thirteen years ago, they hauled it 119 miles last year for the same money. Thirteen years ago the railroads carried 2,923 passengers for each mile of road, and last year they carried 3,036, but the 3,036 carried last year paid the railroads only $1,460, while the 2,923 carried in 1883 paid $1,934. Where, therefore, a passenger paid $1 thirteen years ago, he paid only 85 cents last year; last year the railroads carried a passenger 48 miles and a fraction for $1, while thirteen years ago they carried him for the same money only 41 miles and a fraction.

The price of passenger transportation, therefore, in thirteen years has fallen 15 per cent., and the price of freight transportation has fallen no less than 32 per cent. If, then, the railroads had been able to obtain on last year's business the rates for transportation which ruled thirteen years ago, they would have received $46,000,000 more revenue from passengers and $350,000,000 more revenue from freight, which would have meant $396,000,000 additional net revenue, assuming that it cost no more to do the business than it did. Sticking, however, to facts, we find that each dollar of railroad revenue last year was composed as follows:

Passenger revenue, including mail, baggage, etc.	32 cents.
Freight revenue	68 cents.
Total	$1.00

from which we see that the price of transportation generally (on last year's basis) has fallen over 27 per cent. in thirteen years.

Competition between the railroads themselves, born of speculation; competition incited by depression, with the weaker railroads driven by the stronger, which are then in turn driven by the insolvent; competition fostered, and almost forced upon the roads, by State and federal legislation; competition of waterways with railroads; competition, most of all (as Vice-President Clough of the Great Northern has pointed out), of region with region, and producer with producer,—all these kinds of competition have been aided and abetted by the efforts of a few railroad managers to cheapen the cost of production, these efforts, where successful, lowering the price for all competitors.

In practically all industries other than that of railroad transportation the law of supply and demand holds good, together with the law that the margin of profit cannot be reduced below a certain point without checking production. There is always a point where competition ceases to be profitable, and the weaker go out of business, ceasing to produce. When pig iron falls below a certain price, a very large number of blast furnaces go out of blast; coal mines are shut down, when coal falls in prices and operators can no longer make money; cotton mills shut down, when print cloths fall below a certain price; and the result is that the production of all these things is diminished, which in time remedies the decline in price.

This is not so with the railroads. Once built, a railroad practically never ceases operations. The smaller the margin of profit in the business, the greater the necessity for increasing the volume of business, and the greater the competition for whatever business is offering, thus still further diminishing the margin of profit. This is the experience of all railroads which have had to compete with bankrupt properties. Roads in receivers' hands, with no fixed charges to meet, are, as all railroad men know, frequently most aggressive competitors, although they are admittedly in receiver's hands because they could not pay their way.

With competition growing all the time under these most favorable circumstances, and without the operation of any natural law or compensation shutting off the production of transportation after a certain point, there has been in force a stringent law designed to remove the only protection at the command of the railroads and leave them practically helpless. Without attaching as much blame to the interstate

commerce law and its anti-pooling clause as many railroad men do, it must be said that it has unquestionably aggravated the present trouble.

Thirteen years ago the railroad had to spend 68.78 cents out of every dollar they received for furnishing transportation, and each "revenue train-mile" run cost them 95.75 cents. Last year they spent 70.43 cents out of every dollar earned, and each "revenue train-mile" cost them 93¼ cents. In 1883 each "revenue train-mile" produced $1.50, while last year the return was only $1.33⅓. Of the gross loss of 16⅔ cents per "revenue train-mile" there remained as net loss about 14 cents, the saving in expenses being only 2½ cents.

Now, the actual railroad service performed in running a train-mile thirteen years ago was not very different from that involved in the same operation last year. In 1895 each freight train had a few more cars than in 1883, but that was about all. As far as the railroad companies themselves were concerned, there was not much difference in outlay. The additional cars called for more switching and more handling, but one engine could haul them with almost no increase in cost. Remembering, moreover, that a large proportion of a railroad's operating expenses is not at all dependent upon train-mileage, while another large proportion is only indirectly dependent thereon, it is clear that the physical service performed by railroads—measured by the unit of that service, the train-mile—certainly cost at least as much last year as it did thirteen years ago, and probably more. With an increase of 52 per cent. in train-mileage the decrease in the expenditure per train-mile is only about 3 per cent.

The reason is that, *while there has been a general decline in the price of transportation in thirteen years of 27 per cent., the raw material from which transportation is manufactured has certainly not declined in price as a whole. This raw material is composed as follows: labor, 60 per cent.; material, 40 per cent.;*—a rough division, but sufficiently accurate for our purpose.

There has been, undoubtedly, a large advance in the price of railroad labor in the period, considering all classes of employees. It is hard to estimate it very closely, but the evidence is all in that direction. The chief requisites of railroad-supply stock, such as fuel, steel rails, ties, car-wheels, bolts, spikes, and lumber, are in some degree cheaper than they were thirteen years ago, but labor seems to have advanced so as to offset, and much more than offset, the decline in price, and economy in use, of material. At any rate, it is more than probable that, taken as a whole, the raw material of transportation is no cheaper than it was. Is there any other industry in this country which has had to face a 27 per cent. decline in its product, without a decline in the price of its raw material?

Here is a reasonably complete explanation of the present position of our railroads. This is why a reduction in the volume of business in the beginning of depression proved so disastrous, and drove 25 per cent. of the mileage of this country into the hands of the courts. While there was plenty of business doing, the trouble was masked, and the insufficiency of the working profit was concealed. Concealment, however, was no longer possible under the strain of the 1893-5 depression. Here, then, is our railroad estate to-day after its trial,—somewhat battered, but within sight of better times. What is to be its development in the next few years?

No one can read the future, but here certain broad lines can be laid down, on which certain conclusions can be based. The future of our railroads depends upon *what they can earn*, and that depends mainly upon *what they get for transportation* and *what it costs to do the business*. A third factor, of course, is *the volume of business done*.

The outlook is not very hopeful for an advance in railroad rates in the near future, as far as the greater part of the country is concerned. In the east, and in the thickly-settled part of the country, rates have ceased to decline as local business has grown up. In New England this local and diversified business has kept the rate per ton-mile steady for some years. The same thing is to be noticed in lesser degree in the middle States (New York, New Jersey, Pennsylvania, etc.), and even in the middle west (Indiana, Illinois, Ohio, Michigan, and Wisconsin) the tendency to decline seems at least partially checked for the same reason. These groups contain one-half, or almost one-half, of the mileage of the entire country. It is even a fact that in the northwest since 1890 the average rate per ton-mile has remained very steady at slightly over one cent. This is a very hopeful sign, indeed, considering the comparatively slight density of business in that section. Nevertheless, it is to be feared that serious havoc has been wrought in rates in the year just ended, the effect of which will be seen in a yet lower average.

While it is true that the growth of population and the consequent growth of local business will steady and even probably advance rates in time, it would not be prudent to reckon on any marked improvement in the near future. Improvement must, of its very nature, be gradual, if it comes at all. It may be questioned whether wholesale pooling would do much more than hold rates steady on an average.

How, therefore, are the railroads to earn increased profit for their owners? Clearly, either *by doing a steadily-increasing business* at the present rate of profit, or *by reducing the cost of doing business*. Let us first consider the latter method.

The cost of production depends upon the cost of raw material and

the circumstances of manufacture. The causes which have operated to prevent a fall in the price of the raw material of transportation in the last thirteen years are still in operation. The tendency of the price of semi-skilled labor still seems to be upward, although decline will come some day. There is certainly nothing to warrant the belief that any important lowering of the price of railway labor may be looked for in the near future. On the contrary, increasing business will unquestionably bring demands for advance in wages, and in many cases those demands will have to be granted, at least in part. Let us assume that the price of labor remains unchanged during the next few years. This leaves us but the 40 per cent. of operating expenses representing cost of material in which to hope for a reduction in price.

It may be roughly estimated that train and station supplies account for 12½ per cent., 10 per cent. being fuel. Perhaps fuel may cost less hereafter, but it is cheap now. Rails, ties, lumber, iron, and steel in various forms account for at least 10 per cent. more. Prices for these materials are more likely to advance than to decline. This leaves only about 17½ per cent. to represent miscellaneous items. The prospect for much saving here seems rather doubtful.

Look at it how we will, it seems that the raw material of transportation will not fall much in price in the near future. The railroads are driven back, therefore, on the alternative of concentrating manufacture, so as to cheapen its cost. Here fortunately there are great possibilities. A little has been already done in this direction.

Concentration of manufacture in the transportation industry means the saving of train-mileage,—*i.e.*, economy in units of service performed. It means, therefore, greater efficiency in every train-mile,—more passengers and more tons of freight in every train. In 1883 the number of passengers in each train, on an average, was 45; last year it was 38. In 1883 the average number of tons in each train was 125.86; last year it was 180.23. Calculation shows that, applying the 1883 basis of passenger and freight loads to the business of 1895, there would have been a saving of about 49,000,000 passenger-train-miles, but a loss of 212,250,000 freight-train-miles. Comparing 1895 with 1883, therefore, we see that concentration of manufacture in freight transportation saved 212,150,000 freight-train-miles, while there was a waste of 49,000,000 passenger-miles,—a net saving of about 163,250,000 revenue-train-miles. We may reckon that each revenue-train-mile saved may be valued at about 30 @ 35 cents (this being a rough estimate of the expense items directly dependent upon train-mileage), so that, taking this 163,250,000 at 35 cents each, we have a little more than $57,000,000.

Earlier in this article it was shown that 1895 business done at 1883

rates would have brought in $396,000,000 more than was actually received. Of this amount the railroads have saved only about $57,000,000 by concentration or economy in train-mileage.

The loss in passenger-train-mileage is unavoidable. The railroads have to endure a large waste. That is one reason why passenger business, as a whole, is unprofitable. The saving in freight-train-mileage is, however, considerable, although not nearly enough. It is in this place that the possibilities lie for future profit.

Let us suppose that last year, instead of carrying 180 tons per train, the railroads of the United States had carried an average of 250 tons. This, applied to a ton-mileage of 88,500,000,000 (roughly), would call for a freight-train-mileage of 354,000,000 against an actual freight-train-mileage of 491,500,000. The saving of 137,500,000 of train-miles would have meant an increase in net profit of about $48,000,000, or 15 per cent.

A heavy freight-train-load is a question of two things,—*viz.*, mechanical facilities and good management. It requires, other things being equal, a massive road-bed, easy grades, strong bridges and embankments, capacious rolling stock, and heavy motive power. It also requires extreme care and vigilance on the part of freight agents and yard masters, whose duty it is is to see that trains are well filled before being made up and sent out; for, if the load is not ready, it is useless to have the means of carrying it.

This is the age of steel bridges, 100-lb. steel rails, and 30-ton freight-cars. Renewals are made with heavier rails and larger equipment. In this respect the roads clearly see their duty and their opportunity. Many, however, do not seem yet to see that, while they cannot get more for a given amount of transportation, they can perform that transportation more economically.

There is no apparent reason why there should not be adopted, all over the country, some system of agreement on freight-train schedules, designed to cut down freight service and carry the traffic in a smaller number of trains. This could very easily be done, if the roads were willing, between important common points. Assuming that competing roads had equal mechanical facilities as to road-bed, bridges, grades, and equipment, no one would lose on such an agreement, and it would be just as easy to allow differentials in schedules as it is now to fix them in rates, where the physical facilities of one road are less than those of the others.

The public does not necessarily suffer by diminution in train-mileage, provided the freight is carried and duly delivered. The difference between sixty hours and seventy-two or eighty-four hours, for example, in the time of a freight train between New York and Chicago,

is not much to the shipper, but it is a great deal to the railroad. It might make just the difference between a full load and a load less than full, and it makes a difference in running speed of some miles per hour, involving waste of fuel and wear and tear. The speed question is highly important in itself, as far as freight trains are concerned.

It should not be very difficult to devise a system of freight-train schedules which should cut down train-mileage greatly. A hard-and-fast agreement, such as has been so often attempted on rates, could perhaps be drawn up to limit for each road the number of freight trains to be dispatched per day, due regard being had to the physical efficiency and characteristics of each company. A hundred difficulties in the way of such an agreement could, no doubt, be suggested by practical railroad men, which can be neither anticipated or answered here, but it is submitted that the principle underlying such an agreement is sound, and that enforcement of such agreement, or at least detection of breaches thereof, would be easy and inexpensive. All railroad men know how difficult it is to obtain direct evidence of rate-cutting under existing agreements, and how many ways there are by which rates can be securely and secretly cut.

The railroads have already done a great deal towards bringing their plant up to modern requirements. It is certain, however, that, taking the business as a whole, there has been, and still is, a tremendous waste of energy and money in the shape of train-mileage. Present methods of handling railroad business are relatively as crude and uneconomical as the early process of making pig iron, or spinning cotton. It is in methods that most economies must be looked for henceforth, and the only way to achieve these economies is to lop off unprofitable service.

This matter is in the hands of the railroads themselves, and they can deal with it on the general lines suggested,—*viz.*, by some agreement to limit freight service to actual and well-known requirements between common points and distributing centers. It involves, first, of course, the physical equipping of the roads for the transaction of business in bulk, but, secondly and mainly, the earnest desire of the roads to save money for their owners.

Briefly, then, our argument is this: the railroads cannot safely reckon on an increase in the price of transportation in the near future, nor can they expect a decline in the raw materials from which it is manufactured. Great possibilities for economy, however, exist in the shape of saved train-mileage. (It is fair to say that, with a proper study of the requirements of the public, not only would there be a great saving in train-mileage, but the business could be handled in fewer cars, so that equipment inventories might be smaller.) Also, it is fairly to be assumed that there will be a large increase in the volume

of business done in the next few years, so that the amount of railroad net earnings will be increased, whether there is any increase in the ratio of the profit or not.

The growth of railroad business has been very large in the last thirteen years, and surprisingly steady, although 1893 clearly called a halt. The table which follows gives the "freight density" (*i. e.*, the tons carried per mile of road) for thirteen years, and the yearly average during five-year periods beginning 1883–7.

	Freight density.		Do. 5-year average.
1883	421,421		——
1884	395,196		——
1885	402,521		——
1886	421,124		——
1887	449,396	1883–7	417,931
1888	450,134	1884–8	423,674
1889	446,858	1885–9	434,006
1890	501,303	1886–90	453,763
1891	494,333	1887–91	468,405
1892	494,781	1888–92	477,482
1893	522,305	1889–93	491,916
1894	466,551	1890–94	495,254
1895	494,344	1891–95	493,863

We shall probably not be very far wrong, if we estimate the figures for 1896 at about the same as for 1895, which would leave the five-year average for 1892–6 a shade below that for 1891–5. This would show progress delayed very appreciably, as a result of the 1893 panic and all that it entailed. According to precedent, it would mean that considerable recovery is overdue, more especially as this period of stagnation in freight density coincides with a period in which little new mileage was built, relatively speaking, while population has all the time been growing up to the road already built. It does not seem a very rash thing to say that at some time in the next two or three years freight density will surpass its previous record, and probably exceed 550,000 ton-miles per mile of road. Recovery, moreover, will mean recovery under more favorable conditions than ever before, as every year sees improved plant and improved methods in force, so that the railroads will make more net money, relatively, from the increased freight business than they lost by the decrease from 1892. The same remarks apply in a lesser degree to passenger travel, and it is unnecessary to adduce the figures for this department.

We may, then, confidently expect a considerable increase in the amount of railroad profits from an increased volume of business in the next three to five years, independently of rates, wages, or even, to a certain extent, train-mileage, economy, or waste. In this increase of profit lies the opportunity of the railroads to prepare for the future.

If railroad managers in the next two or three years will regard increased profits as a fund on which to draw for money to reduce grades, build heavy locomotives and large freight-cars, lay heavy steel rail, and replace wooden bridges with steel, iron, and stone; and if they will, in addition, agree to try to limit train service to absolute requirements, so as to stop the waste of train-mileage,—they can place the railroads beyond danger of another 1893–5 period, with its list of bankruptcies and defaults, and will be able to face almost any contingency in the future. This, or much of this, however, must be done.

Without making invidious comparisons or drawing unpleasant distinctions, attention may be called to some conspicuous examples of scientific railroading. Great Northern (considering its natural disadvantages) is one,—perhaps the best; Lake Shore is another; Chesapeake & Ohio is another; all these companies are getting relatively more and more profit out of the business done year by year by saving in train-mileage. They can live where others could not, because, for every freight-train-mile run, they get a larger average sum year by year. That is really the whole problem.

It is for this reason that it may be said that the destiny of the railroads is very largely in their own hands. It may be made a bright destiny by rigidly applying to the industry the forethought, science, and economy that is applied in other and simpler industries. The suggestion is hazarded that the problem has been tackled at the wrong end hitherto by the majority of railroad men. They have striven to control the market for their product, but have neglected the question of its production. They have wrangled, quarreled, and fought over rates and tonnage, but they have over-looked the main question,—namely, the amount of work they were doing with that tonnage in wasted train-mileage. Profit depends at least as much upon cost as upon selling price.

Even the most casual observer cannot fail to appreciate the stupendous importance of our great railroad estate, unless, indeed, it has become by acquaintance a commonplace. Such commonplaces, however, lose their stale appearance on investigation. An investment represented by twelve billion dollars of capital is a serious matter. The time is ripe for the managers of this investment to place it once and for all on a solid foundation. If money is needed to do this, it will be furnished in the next two or three years in abundance, by the return of prosperity. If they but grasp the opportunity and use it rightly, the time of fiery trial for the railroads of this country will have passed forever.

NOTE.—The figures relied upon in this article were taken from Poor's Manual, which is the best available record.

THE HOPEFUL OUTLOOK IN THE MECHANICAL WORLD.

A Symposium.

IN the leading article of this Prosperity Number, the general conditions promising a great revival of business are reviewed broadly from the standpoint of the general economic and industrial conditions.

To present the subject in a slightly different light and sum up the situation in another, but no less striking, way, we present below a most valuable symposium of opinions from leading manufacturers,—men who are in actual contact with the trade, watchful of every movement and directly affected by every turn in business affairs. An accurate and most important index of the state and prospects of our industries is thus afforded.

FROM THE WEBSTER CAMP & LANE MACHINE CO., AKRON, O.

The business depression of the last four years has taught many of the progressive manufacturers of this country to look for new markets in which to place their goods, and the increasing demand for American goods and machinery in Mexico, South America, and South Africa is an indication that their efforts are meeting with success. In the mining machinery line—in which we are interested—this has been especially marked, and the foreign demand for American mining machinery has been a wonderful help in tiding us over an otherwise very depressing period of inactivity. This demand for American goods may be increased, if manufacturers will take the pains that German and English makers take to study carefully the wants and peculiarities of the people they wish to deal with, and to see that the goods are packed in a manner to stand the transportation.

The increased competition in all lines of home trade has called forth many new and interesting improvements in processes of manufacture and rapid handling of materials, notable among which have been the increased use of compressed air in shop-handling of machinery and material and the handling of large quantities of coal and ore at all Lake ports, by means of apparatus for dumping railway cars direct into vessels, without the delay and expense of shoveling, etc. The designing and construction of this improved apparatus have done much to keep the various engineering establishments busy. Now that political matters are, for the most part, settled and out of the way,—the uncertainty and lack of confidence factor being eliminated,

—there is every day more apparent a better feeling, both in commercial and financial circles, and though, happily, there is no prospect of a sudden boom, there is every indication of a gradual improvement in general business. Our customers are giving evidence of this in a substantial way, by placing orders which have been held over until after election. They had the best of reasons for this, as they had no assurance of being able to finance their schemes of improvement until a settled financial policy should be guaranteed.

We are happy to state that we are now assured of a good winter's work for our men, and we have from present inquiries—daily coming in—good prospects for business for 1897.

S. H. PITKIN, General Manager.

FROM THE BERLIN IRON BRIDGE CO., EAST BERLIN, CONN.

In our opinion, nothing stands in the way of a business revival, except a business revival. There is an old saying that nothing succeeds like success, and we are inclined to think that, if people would stop growling and attend to business, business would come.

Our exports are large, the prices of our farm produce have increased, consumption in the past three years has been going along, but production has very materially diminished. The result is that sheer necessity must soon drive us all into the market, and, as soon as labor is employed, business will revive. Our greatest fear is a boom,—that is, that the revival will come quickly, and production will not be ready to meet the consumption, or, in other words, that the demand will be greater than the supply. CHAS. M. JARVIS, President.

FROM WM. SELLERS & CO., INCORPORATED, PHILADELPHIA.

We had no orders contingent upon McKinley's election, nor did we have any inquiries for work based upon that contingency. We had probably more inquiries before the election than we have had since, in the same time, but the monetary conditions then were widely different from existing ones. Then a general feeling of distrust prevailed, and business paper could scarcely be negotiated at all; now there is an increasing confidence in the future, and no difficulty is found in negotiating legitimate business paper. It is probable that the distrust existing before the election prompted many inquiries, and that the inquirers now feel that they can wait for further evidence of recuperation. Very many of our orders for the last few years involved the use of electric power and electric transmission, and this agency promises increasing proportions in the future. New developments in special industries have furnished considerable orders that must soon be duplicated, and our export trade has been larger than usual,—a condition probably consequent upon the low prices here, due to the

general stagnation of manufacturing and transporting industries. At the moment business is dull, but we share in the general opinion that a revival may be looked for in anticipation of wiser legislation under the new administration. WM. SELLERS, President.

FROM THE LIDGERWOOD MANUFACTURING CO.

It is impossible to have a permanent improvement in business while we have to suffer the infliction of the present congress. The reform of the deplorable state of our national finances—the first step to business prosperity—is utterly ignored. Consequently the present spasmodic condition of trade is likely to continue.

JNO. H. LIDGERWOOD, Treasurer.

FROM THE EGAN CO., CINCINNATI.

The business situation at the present time is more perplexing than usual, and we will explain the reason why. After the election of McKinley we had considerable business hanging on that event. Most of this business materialized, and we filled the orders. We had expected, of course, that these orders would continually multiply and business go right along, but to our surprise business has not kept up as it should. The tone of business looks better, and money is easier, and the banks are more willing to discount good paper, and at a lower rate than ever before. It looks to us as if people are waiting for the new administration to come in. We cannot account for it in any other way. Business, we will admit, is a little on the improve. And yet we had expected so great results that it has not quite fulfilled our expectations. We think that when the new administration begins everything will come along to our satisfaction. THE EGAN COMPANY.

FROM THE BROWN & SHARPE MFG. CO., PROVIDENCE.

We have noted in our business a perceptible, though not great, improvement since the election. Only one small order was marked as contingent upon McKinley's election, but our customers seem to regard the election as of probable benefit to them.

During the past year we have been exceptionally busy, owing, we think, chiefly to three causes: an unusual demand for our tools abroad, the orders from the bicycle trade, and the general interest shown in the new designs of our standard machine tools.

Our own desire for the future is that congress should speedily enact some satisfactory legislation in regard to our currency, and should not in any way subordinate that issue to the tariff. If uncertainty in regard to the currency is removed, and general business is not disturbed by a comprehensive change in the tariff, we see no reason why there should not be a large and steady increase in the volume of trade.

BROWN & SHARPE MANUFACTURING CO.

FROM THE HEINE SAFETY BOILER CO., ST. LOUIS.

From our individual standpoint, the business outlook seems very promising. There has been no recent boom in the boiler business, but, as we see it, this is a matter for congratulation rather than regret. A gradual revival of trade, such as we have experienced in the last few weeks, is much more to our liking, and much more promising of continuation. We are feeling very well satisfied, and very hopeful for the future. We anticipate that competition in general will be keener than ever from now on, but we regard that aspect of the situation complacently, for the reason that we think it will involve a closer attention on the part of manufacturers to all possible economies in the operation of their plants. That must mean better business for the manufacturers of fuel-saving boilers and labor-saving machinery in general.

S. D. MERTON, Secretary.

FROM CAHALL SALES DEPARTMENT, PITTSBURG.

For three years general business in our trade has been extremely dull, having shown a steady decline for the full term of three years until March, 1896. The three months following March were very good, and then came an almost total collapse. Almost immediately following the election of McKinley, business picked up very materially, and during the first three weeks after the election it was better than it had been for over a year. Then, for some reason, purchasers throughout the country felt probably that they had overestimated immediate advance in business conditions, and things fell off again, until for the last two weeks both inquiry and actual business have become almost as bad as they were in the past summer. A thorough canvass of the various territories covered by our agents seems to indicate that there will be almost nothing done until after manufacturers have checked up their stock accounts and taken off their trial balances the first part of January, and are able to determine exactly where they stand. The general promise of business for the ensuing year seems to be very good, but it will be impossible to forecast with any degree of accuracy whether this promise will be borne out until about the middle of February. If at that time purchasers do not commence to be active, there is no telling when a healthy reaction will set in. As for our own feelings in the matter, we can only say that we have been very fortunate during the dull times, and, if business is not worse with us in 1897 than it has been in 1896, we shall have no reason to complain.

CAHALL SALES DEPARTMENT.

FROM THE JOSEPH DIXON CRUCIBLE CO., JERSEY CITY.

Business prospects are good,—at least to all who are in any way hopeful or energetic. When we look back over 1896 with an eye single

to honest retrospection, we have rather more reason to criticise our own methods than the business situation or the condition of the country. We have slumped, as it were, in those lines where we have been somewhat easy and over-confident, and we have increased largely in those lines where we have put in vigorous and intelligent work. We have also, by extra work and attention, held our own in lines made dull by the stoppage of the many industries in the land.

In looking at the total outcome of 1896, we find we are a little behind 1895,—about 10 per cent. Had our foresight been as good as our hindsight, we believe we could have equalled 1895, if not outdone it. One of Mr. Atkinson's favorite quotations from Emerson is that "man is as lazy as he dares to be," and probably business men are not exceptions.

The outcome of the election made some little difference with us, for we held several orders dependent on the election of McKinley. As we have been personally told of other concerns that held contingent orders, in some cases aggregating a hundred thousand dollars, we have no doubt that McKinley's election was a benefit to the country.

There is no denying the fact that accounts have been hard to collect. We believe our customers have been anxious to pay promptly. We know they have written us manly and business-like letters, but money has been exceedingly hard to get hold of, and notes have been unsatisfactory, because renewals rather than payments were bound to be made.

Our experience is that it has been a season of hard times and many moments of uncertainty, but that nevertheless the spirit of self-help and mutual help has been alive, and is now rapidly making itself felt in the way of better business, which will be still better later.

JOS. DIXON CRUCIBLE CO.

FROM THE LINK BELT ENGINEERING CO., NICETOWN, PHILA.

We are not of those who looked for prosperity in a golden shower on November 4. That restored confidence is not yet translated into higher prices and greatly-increased demand for product should not be cause for disppointment or surprise.

McKinley's election relieved the financial situation. Money is easy of access for all legitimate needs, including discounts.

Orders for repair work and maintenance of manufacturing plants which were held back till the result of the election could be known have since been coming forward to a stimulating extent in machinery lines, but caution, born of the experience of the past three years, still keeps the brake on investments in new enterprises, and they will probably move slowly till a new tariff has been framed and the ability

of the new congress to enact the laws essential to continued prosperity has been demonstrated.

In existing conditions we find distinct improvement, and the outlook is for an increasingly rapid development in engineering and mechanical lines. THE LINK-BELT ENGINEERING CO.

FROM FRASER & CHALMERS, CHICAGO.

Our business is active, and we expect continued activity and a prosperous season. We base this opinion upon the simple knowledge that much work is to be done which we, as a firm, are able to execute to the advantage of those requiring it. FRASER & CHALMERS.

FROM H. K. PORTER & CO., PITTSBURG.

We hardly know what reply to make to you. We are having more inquiries at the present time, and greater correspondence, than we ever remember of heretofore, and with every indication of very marked improvement in business in the near future. We ran at approximately half capacity throughout the depression, and are not running nearly full capacity now. We are trying to be conservative on prices, with the hopes of avoiding a boom. Our business includes both home and foreign. People appear to have been postponing purchasing, and quick deliveries are generally asked for. H. K. PORTER & CO.

FROM THE STIRLING CO., CHICAGO.

There has never been a statement submitted to our stock-holders that can compare with the statement that will be submitted to them at the end of this year, in point not only of satisfactory earnings and large volume of business, but also of a most flattering outlook for the the future. Much that is satisfactory in our report can be attributed directly to the favorable financial and political developments within the past sixty days. As a direct result of McKinley's election contracts that had been closed conditionally for large amounts became immediately effective, and a great number of concerns that had been deferring needed improvements, either because of the disinclination to spend money, or because of inability to market their securities, have opened negotiations for extensive additions to their plants.

The outlook, while it is not without a fleck of cloud here and there, is encouraging, and certainly seems to offer the promise of eminently satisfactory returns to all manufacturing concerns that proceed with vigor, and at the same time with caution.

EDW. R. STETTINIUS, Treasurer.

FROM THE EDWARD P. ALLIS COMPANY, MILWAUKEE.

During the past month we have received about the customary num-

ber of orders. We notice no special change in the volume of business since election. Our works are fairly well occupied, and we were for tunate enough to have a fair amount of business on hand most of the time during the past two years. THE EDWARD P. ALLIS COMPANY.

FROM THE PRATT & WHITNEY CO., HARTFORD.

Every one knows how strained the situation was prior to November 4. Since that date the aspect of affairs has completely changed, and where buyers of our goods did not wish to even discuss the possibility of a purchase they are now inquiring from every direction.

A few orders were placed with us contingent upon the election of Mr. McKinley. We think that the majority of our customers now regard the present conditions as very satisfactory, and look for a large business during 1897, and a still larger one in 1898.

Neither they or we expect or wish for what is commonly known as a "boom." The disappointment at the slow revival of business which we hear now and then expressed appears to emanate only from over-sanguine individuals who expected the country could recover from its very serious condition in the course of twenty-four hours. One satisfactory point we have noticed is the greater promptitude in paying accounts and settling up old standing matters. This is undoubtedly caused by the greater facilities extended by bankers all over the country to their customers. The question is not now how much accommodation will the bankers give their customers, but how much money can the customer use. Of course, in saying this, we refer only to firms of the highest standing.

The extended increase in the use of bicycles has had a material bearing on our business, as we have been called upon to equip factories all over this country for this purpose, and have also shipped similar goods to various European points. It seems as though the bicycle craze was just getting into full swing in Europe, as factories are springing up everywhere.

Our export trade is steadily increasing, and there is hardly a country in the world from which we do not receive inquiries for some goods of our manufacture. J. C. STIRLING, Treasurer.

FROM THE JONES & LAMSON MACHINE CO., SPRINGFIELD, VT.

We would say that the condition of business, as we have found it, is best reflected in our running time, which during the first six months of 1896 was sixty hours a week, and then fell to thirty-two hours a week, the latter rate continuing until one week after election. Since then we have been running forty-eight hours a week.

Our orders seem to go up and down with the stock market to an extent that would indicate that convalescent business is extremely

sensitive on its bump of confidence, which was made sore by the recent tumble. JAMES HARTNESS, Manager.

FROM J. A. FAY & CO., CINCINNATI.

We are pleased to find the business outlook such as to fill us with a reasonable hope that in the very near future we shall begin to reap the benefit of an increased volume of business. Unquestionably we have with us the ear-marks of an early resumption of at least normal times. We find collections easier, and in some localities there has already been improvement in orders. We are happy at the outlook.

J. A. FAY & CO.

FROM THE A. S. CAMERON STEAM PUMP WORKS, N. Y.

We have not experienced any marked improvement in business since election, but, from what information we have been able to obtain, we have every reason to anticipate a decided change for the better this coming spring. THE A. S. CAMERON STEAM PUMP WORKS.

FROM THE DEANE STEAM PUMP CO., HOLYOKE, MASS.

The pump manufacturers probably come in contact with a greater variety of enterprises than any one industry. Mining, manufacturing, building, railroads, electricity, and shipping all involve the use of hydraulic machinery, and we have to meet these interests daily.

There has been no marked increase in orders for machinery since the national election, and very little increase in inquiries. There is, as before, a large volume of business waiting for an uncertain future.

During the past three years every branch of business has suffered. Some have been much more affected than others, and a few have been entirely crippled. Some men, with ample funds at their command and with undaunted faith in the permanence of our institutions, have taken advantage of the low prices of the period to make improvements in their plant and equipment.

On the other hand, the majority of business interests appear to be still waiting for the return of prosperity before making purchases or instituting contemplated improvements.

The laboring classes are users and producers of all products. They have been taught economy by the hard experiences of the past few years, and must continue to practise it until labor is much more in demand than at present. Our observation leads us to the opinion that there will be a gradual and increasing demand for labor if there is no untoward legislation, such as a revision of the tariff to too greatly increased duties or beyond a reasonable basis for necessary revenue. We believe that, as each industry in its turn feels the improvement, it will help all allied interests. LEWIS E. BELLOWS, General Manager.

THE AMERICAN PRESS

Historical Sketch of the Bessemer Process.

AN account of the origin and development of the bessemer process, and a defence against the statement lately put forward in some quarters that the invention was anticipated by W. Kelly, an American, was presented in a paper by Sir Henry Bessemer at the December meeting of the American Society of Mechanical Engineers. It seems clear from this account that, although Kelly secured a patent in November, 1857, the process of making bessemer steel could not have been carried out in such an apparatus, which would project and discharge vertically a large proportion of its contents during the explosive eruption of slags which always occurs towards the end and is an inseparable concomitant of a successful conversion. We think no unbiassed person can read this paper without arriving at this conclusion. A very convincing undertone of candor pervades the paper, adding force to its statements.

Sir Henry Bessemer commenced his experiments in 1855. They were first directed to toughening cast iron by the fusion therein of malleable scrap iron. Previous experimenters had sought to do the same thing, but their efforts had resulted in a white cast iron, so much contaminated with sulphur that the method had largely failed to reach the object sought. Bessemer used a reverbatory furnace, in which the pig-iron was fused, and into this bath he put pieces of Swedish or other charcoal iron, which was thus fused out of contact with the fuel. This avoided the absorption of sulphur. His patent for this process was taken out in January, 1855. Of course there followed alterations and modifications. The result was a metal which, when annealed, had a fine grain and great strength, and which, when polished, looked like steel. Of this metal Mr. Bessemer made a small model gun, and took it to France, where he exhibited it to the emperor, and obtained permission to establish a cannon factory at Ruelle, near Angoulême.

Sir Henry returned to London and resumed his researches, during which he was diverted from the Ruelle project by results obtained in his experiments. Two months later he took out a patent for forcing air into the closed ash-pits of furnaces for making cast steel, as the outcome of his attempts to increase temperature by the use of a larger furnace and a forced draft.

At this point his open-hearth experiments were abandoned. While he makes no claim to a prior invention of the Martin-Siemens process patented in 1865 by Emile Martin, he thinks he certainly approached within a measurable distance of it. Bessemer was diverted from this line of experiment by a phenomenon which he observed in his open-hearth experiments. Some pieces of pig iron in one side of the bath remaining unmelted, he turned on a little more air through the fire bridge with the intention of increasing the combustion; but at the end of half an hour they still remained unfused. He then took a bar of iron to push the unmelted pieces into the bath, when he found that they were mere shells of decarburized iron. Here was the indication that air alone could decarburize gray pig-iron and convert it into malleable iron without any further manipulation. By following up this clue skilfully the great invention was reached.

Emphasis is placed upon rapidity of action as essential to success; in this way

only can the necessary high temperature be attained,—a temperature considerably above the point at which malleable iron fuses, and which prevents the cooler deoxidizing metal from chilling it, or the formation of skulls in the casting ladle while the ingots are being poured. A knowledge of these conditions and requisites, it is claimed, does not appear in the specification and drawing of the Kelly patent of 1857.

Mr. Bessemer also alludes in his paper to his anticipation of Mr. Mushet's use of German pig-iron for recarburation of the converted metal after the blow, this anticipation having been described in his patent taken out October 17, 1855. In his patent of May 31, 1856, he claims to have anticipated also Sir Joseph Whitworth's invention for casting steel under great pressure. From this point on the advances were confined to details, until finally the semi-rotary converter crowned a long list of improvements.

All this has been often retold in various forms and places. The principal interest of Sir Henry Bessemer's paper, apart from the inherent interest in any story of a great invention, lies in the fact of his having been elected an honorary member of the society before which the paper was presented, and his high appreciation of this honor, as expressed in his opening remarks.

Newer Tendencies in Street-Paving.

AN editorial upon "Narrower Pavements for City Streets" is introduced, by *The Engineering Record*, with some excellent comment upon a noteworthy change in the policy of municipal engineers, observable in many recent cases. The change is properly regarded as a distinct advance. "The rising standard of municipal engineering in American cities," says the *Record*, "is shown in the increasing space given in the annual reports of city engineers to discussions of improved methods of practice and suggestions for further improvements. The old-style report, confined to numerical tables of work done, is becoming a rarity, and suggestions as to desirable changes in present working methods are to be found in the reports from nearly all of our cities."

This is as it should be. The executive officers of towns and cities and the members of executive boards are rarely men of technical education, or competent (even when desirous of doing so) to originate improvements in places or methods of work.

The engineer with a proper appreciation of his relations to the employing corporate board and his duties to the public will have no hesitation in going beyond the letter of his instructions in advice and recommendation, and no fear that critics worthy of respect will consider such action *ultra vires*.

The *Record's* comment is called out by the "particular instance" of "the subject of street paving, whose economics are now being very carefully studied. One result of this is a tendency in many places to reduce the width of the paved portion of residential city streets, necessitating an increase of the sidewalk width or in having a wider strip of grass between the sidewalk and gutter. In the days of cobblestone pavements, now rapidly disappearing, it was cheaper to have narrow sidewalks and broad roadways, but, with the introduction of asphalt and brick as paving materials, and the recognition of the necessity of having a solid, though expensive, foundation under all pavements, the economy of having narrower roadways soon became apparent, and the wide, unkept street of village days has given way to the narrow, well-kept city street. It is generally admitted that a wide street is handsome, but that it is just as handsome with a paved carriageway of moderate width and a broad stretch of grass between the sidewalk and curb does no seem to have been as quickly realized. There is many a wide street in our smaller cities and towns that has no pavement or a poor pavement, because the expense of paving the present width of roadway is too great."

Direct examples of the effects of this tendency are cited in the cities of Toronto and Albany, where a reduction of five or six feet in paved width of residential

streets has "improved the appearance of the streets, and given satisfaction to the residents." Further economical arguments are advanced in the reduced expense and labor of cleaning and sprinkling the narrower pavements, and in the convenience afforded by the idle strip as a dumping-place for snow from sidewalks, gutters, and roadways, in all cases where no regular provision is made for the removal of the snowfall.

There is one influence bearing upon the relative width of roadway and sidewalk which is not mentioned in the discussion in the *Record*, but which must undoubtedly be dealt with,—the bicycle. Overdone at present, perhaps, it is nevertheless beyond question an enduring development, and the transfer of so large a volume of street traffic from the sidewalk to the roadway will have to be allowed for in some adequate way. Possibly the solution may be found in making three divisions of the traffic, and the side-strips, specially and perhaps lightly paved, may accommodate the lighter vehicles.

An exchange recently announced that Gen. Collis was considering, or had adopted, a plan for laying a narrow asphalt strip next to the curb on granite-paved streets in New York, so as to relieve the congestion of bicycle movement on the fully-asphalted thoroughfares. The craze for wheeling has excited so much merited ridicule that it is hard to regard it seriously; but it has a sober side and substantial claims, which the modern city engineer must recognize and reckon with.

The Cyanid-Process Patents in the Transvaal.

THE decision of the high court of the South African Republic, pronouncing the MacArthur-Forrest cyanid patents invalid, is one of the most talked-about recent events in mining and financial circles.

An able editorial in *The Engineering and Mining Journal* (Nov. 14) discusses the obvious and probable future effects of this decision upon the gold-mining industry in the Transvaal, and elsewhere. It was in the Transvaal that the cyanid process first came into use. Nevertheless, as pointed out by our contemporary, it is a fact that, in connection with the long and vigorously-contested litigation to which the patents have been subjected, American expert testimony has been largely relied upon in the contest, this testimony having been taken in New York by a special commissioner from the Transvaal. The earnings of the mines in the South African Republic were largely increased at small cost by leaching tailings with cyanid solution. As a consequence, the process was adopted elsewhere. At first royalties were paid by the Transvaal mine-owners without demur, but increasing resistance to payment of royalties at last led to the suit which has terminated thus unfavorably to the African Gold Recovery Company owning the patents for that country. The editorial referred to reviews briefly the situation in other countries. In England the validity of the patents has been adversely passed upon, but the case has not been carried up to the highest court. The patents in Australia have been amended and their scope reduced. They are owned by The Australian Gold Recovery Company. It is said that the use of the process on an extensive scale has been commenced in the gold mines of New Zealand. Little has been done with the process in Mexico, though the patents for that country were sold to a company for a large sum. The patents in this country are owned by the Gold and Silver Extraction Company of Denver, and the process is said to be in use in several places. A suit brought by the company to recover royalties from the Mercur Gold Mining Company, in Utah, was compromised on terms so favorable to the defendants as to indicate a want of confidence on the part of the Gold and Silver Extraction Company that they could obtain a decision favorable to their claims. Thus the patents have never been brought to a judicial test in the United States.

Our contemporary makes some remarks relative to misleading comments upon the decision of the Transvaal court, and designed to correct misapprehensions as to the importance this process holds among means for getting gold. It says: "The de-

cision just given, though final so far as it goes, applies to the South African Republic alone. It is not binding upon the courts of any other country, though it might incidentally have considerable effect upon their opinions. Even if of general effect, the result of the decision would not be so great as some of our contemporaries seem to think. Potassium cyanid is not by any means a universal panacea for refractory gold ores. In many places it has failed to give satisfactory results, and has nowhere attained so close an extraction as the chlorination process, for instance. In some cases, as in the Transvaal, it has been a very efficient help, but its range of usefulness is limited to certain classes of ores. It may be doubted whether the gold production of the world would have been very much less than it is to-day, had its peculiar solvent properties remained unknown, since the use of chlorine, bromine, and other chemicals would have taken its place. To say, as one writer did recently, that the use of cyanid opened vast possibilities for increased production of gold all over the world is simply nonsense. . . . After all, the chief effect of the decision will be to cut off a large part of the revenue of the African Gold Recovery Company, and therefore of its chief stockholder, The Cassel Gold-Extracting Company, and, by relieving the Witwatersrand mining companies from the payment of royalties, to give them some aid in the reduction of expenses, which many of them sorely need to make."

Power Absorbed in Driving Shafts and Belts.

THE fact has long been known that much power is wasted needlessly in driving shafts, belts, and counter-shafts, in the average shops and factories throughout the country. There are, however, notable exceptions, where simplicity in arrangement, perfect alignment, and thorough lubrication appear to have reduced loss of power to a minimum. The magnitude of this loss has been urged from time to time upon public attention, but experiments to determine it, described by Mr. C. H. Benjamin in a paper presented by him at the December meeting of the American Society of Mechanical Engineers, are of value,—at least as cumulative evidence. No great degree of accuracy is claimed for the results obtained, but Mr. Benjamin thinks them reasonably close to the truth. The method employed was to take indicator cards at about hourly intervals, while a factory was in full operation, and, during the noon hour or after working hours at night, to take cards from the engine when driving line and counter-shafting only. "Averages of these two sets of cards are assumed to show respectively the total horse-power and the friction horse-power in that establishment." The method could easily introduce grave inaccuracies in estimating the loss of power due to friction of line-shafting, counter-shafting, and belts, as the sum of these and friction losses of the engine would be represented by the differences of power indicated by the average total horse-power cards and the average friction horse-power cards. Any one familiar with the running of a steam engine can judge how wide a variation in the friction of an engine can be made through adjustments of bearings, stuffing-boxes, piston rings, gibs, and slides. The separation of the frictional loss, determined by cards so taken, into parts indicating that due to the engine and that due to the system of shafts, countershafts, and belts would be a work of difficulty. What would thus be shown would also be different from the friction of the shafts, etc., under full working load, thus adding to the difficulty of apportioning the friction losses to the different parts of the system of transmission. However, there is no doubt that some general indication of the needless losses caused by friction would be gained by such experiments. Tables of data presented show results that, in some instances, almost stagger belief. Taking the range of sixteen establishments, they show that from fifty-five to sixty-five per cent. of the power of the engine is absorbed by itself and the transmitting mechanism before the useful work is reached. Much of this is attributable to imperfect lubrication, but probably more loss results from complica-

ted systems of shafting; and Mr. Benjamin suggests the wisdom of considering electrical transmission in cases where such complications would be otherwise necessary. The following suggestions for reducing the friction are made:

"Use pulleys of large diameter on counters and narrow fast-running belts. Use nothing but the best oil and plenty of it, catching all drip, and either purifying it or using it for some other purpose. Have all the shafting and counters oiled regularly, and do not depend too much on automatic oiling. Inspect line shafts from time to time, and see that they are in line and can be turned easily."

American Street-Railway Property.

VERY few people outside of railway circles realize the magnitude of the street-railway industry at the present day. The prosperity of street-railways, as contrasted with other railway enterprises, is little thought of by the general public. The fact is that some of the very best investments are found in street-railway property. This fact cannot fail to be impressed upon the minds of even casual readers of "The Great Street-Railway Properties of America" in the *Street Railway Journal* for October, which contains a tabulated statement of the financial characteristics of twenty-nine surface and elevated roads, whose gross annual earnings equal, or exceed, one million dollars. While much of the railroad property in the United States has been placed in the hands of receivers, it is a notable fact that only two of the twenty-nine street-railway systems thus tabulated have ever been in the hands of a receiver or experienced any serious financial embarrassments. The strength and the weakness of each of the great properties named are also discussed in the article. Thus the Manhattan railway system, of New York, which is second in value and importance only to that of the Union Traction Company of Philadelphia, is shown to be earning $269,600 per mile of road, or $96,700 per mile of track. The Union Traction Company, with more than double the capital stock of the Manhattan Railway Company, earned in the year ending June 30, 1896, the sum of $10,210,026, while the earnings of the Manhattan for the year ending December 31, 1895, were $9,731,213, or only $478,813 less. The Union Traction Company owns four hundred and thirty miles of track, whereas the Manhattan Railway Company owns only a fraction over one hundred miles. The earnings of the latter per mile are, therefore, more than four times the earnings per mile of the Union Traction Company. As compared with the earnings per mile of the New York Central and Hudson River Railroad, the earnings of the Manhattan Railway per mile are more than fourteen times as large. The road is operated for sixty per cent. of its gross receipts, nineteen and one-tenth per cent. of these receipts being required to meet interest on the funded debt. It is thus shown that, while the possibility of reductions of dividends is admitted, the affairs of the company are extremely prosperous. The Metropolitan Railway of New York presents an example of a railway system with seemingly great possibilities. "It operates one hundred and eighty-nine miles of track, improved motive powers being used on less than twenty per cent. of the mileage. Its lines are a network covering the entire lower end of the city, while it controls or holds the key to eight out of a possible eleven north and south avenues running lengthwise of the island. Its cable and electric lines, which form seventeen per cent. of its entire mileage, are earning thirty-nine per cent. of the gross revenue." Notwithstanding this fact, its earnings per mile are exceeded by only three other roads, one of which is the Third Avenue Railroad of New York, a surface cable road of phenomenal earning power with comparatively small mileage. Its earning power is placed at $190,700 per mile; its cost of operation is about fifty-five per cent. of its gross receipts; its interest charges are only nine and four-tenths per cent. of its gross receipts; and its dividends for the last two years have been eight per cent.

These are samples of the kind of information given in the compilation under notice, which will be very useful as a guide to investors, and will afford to the general

reader a means of comparing the magnitude of the street-railway industry with other great American industrial interests.

Corrosion of Iron and Steel Used for Building Purposes.

SIGNIFICANT facts were presented in a paper by Mr. M. P. Wood at the December meeting of the American Society of Mechanical Engineers. The paper is the fourth presented upon the topic of rustless coatings for iron and steel. The author states that it was intended that the paper should be devoted to the subject of oils and other vehicles used in paint processes. But, since the third paper was presented, "so many examples of the vagaries of corrosion of metallic bodies have presented themselves . . . that, in lieu of the vehicle subject," the author presents "a case of corrosion of so remarkable a character, and one in which the record is so positive in its details, that it is removed from the category of speculation as to its cause." A case reported in *Engineering* (July 31), wherein the engines and boilers of the steamer Glenarm were almost destroyed by corrosion during a six days' submergence after striking a rock in the Sound of Mull, is cited as proving the fact that oiled and painted surfaces may be made very resistant to corroding agents. While the parts not oiled and painted were almost entirely corroded, so that they might easily be cut with a pocket-knife, those coated with oil were scarcely affected. Mr. Wood casts doubts upon the durability of the tall metallic structures that have been erected. He alleges that "it is an indispensable condition in applying paint for the protection of metallic surfaces—disregarded in many of these buildings—that the surface must first be prepared by cleaning it to receive the paint;" and that "the manner and time of applying the coating are strong factors towards getting a favorable result." In previous papers cases of destructive corrosion where this action is very apparent were cited. These include so important structures as the Niagara Falls and Brooklyn suspension bridges, the Victoria tubular bridge across the St. Lawrence river at Montreal, the Firth of Forth cantilever bridge, and elevated railway and viaduct constructions in New York. Of these the author now remarks that there was "evidently a wrong conception from the beginning of what was necessary for the protection from corrosion of these costly structures, so that their life could be measured by the lapse of centuries instead of decades."

With reference to the new suspension bridge between New York and Brooklyn, the North river bridge, and the East river cantilever bridge,—"three of the most costly and important metallic structures" in the world,—the author implies the hope that, in view of more advanced knowledge upon the means of producing rustless coatings, these structures will be better protected than those previously named. He condemns the use of linseed oil free from any pigment, and also the use of oxid of iron in any form for the protection of metallic surfaces. Great stress is laid upon the preparation of surfaces before applying the paint. A poor paint upon a properly-prepared surface may be even more effective than a good paint upon a surface improperly prepared.

Passenger Elevators.

A RECENT accident to one of the elevators in the twenty-two story building of the American Tract Society in New York city was made the occasion of a sensible and timely editorial in *Engineering News* (Nov. 26). As the passenger elevator has made the tall-building system practicable as a business enterprise, so upon its reliability and safety the perpetuation of this system of construction must depend While absolute immunity from accident can hardly be expected from any human contrivance, when the liability of accident becomes reduced to a possibility sufficiently remote, it may be disregarded, like a negligible quantity in mathematics; and the infrequency of accidents in passenger elevators showed that this means of conveyance, a few years ago, was nearly or quite brought up to this standard of safety. But with increase of height in buildings has come the practical necessity for in-

creased rapidity of motion, and this may easily introduce a factor of increased hazard, unless most careful attention is bestowed upon mechanical construction and design. The point made by our contemporary is that it would require but a very few such accidents as that in the Tract Society building to cause such a loss of confidence on the part of tenants as would react most unfavorably upon the rentals of offices in tall buildings; and that, therefore, it is a matter of vital importance to all in any way interested in such buildings to see that accidents of the kind named (or of any other dangerous kind) to passenger elevators should be rendered practically impossible. Reliance upon the inspection of any municipal or State bureau is shown to be unwise from a comparison of the reports of the New York building department for the years 1895 and 1896, which show that either the inspection for 1896 was much too severe, or that of 1895 was much too lax. In 1896 nearly twice as many inspections were made in the first nine months by this department as were made in the first nine months of 1895, and 856 elevators were reported defective, as against 62 so reported in 1895. Does any one believe that nearly fourteen times as many defects existed in 1896 in less than double the number of inspected elevators? If this were possible, it would of itself justify general alarm among the tenants of high buildings. In 1896, 912 elevators were made safe on notice from the department, while in 1895 only 44 were made safe on such notice, and it is pertinently asked: "what guarantee have we that," as regards thoroughness of inspection, "we may not in a year or two return to the conditions of 1895?" It certainly seems that elevators can be designed to run with sufficient safety at a speed of from six to seven hundred feet per minute,—a speed thought necessary in buildings of fourteen stories and upward; but, with the highest skill and most perfect construction, the necessity for strict vigilance cannot be obviated. Without constant vigilant care and inspection all safety appliances, are liable to fail when it is most essential that they should act promptly and efficiently.

A Study in Water Purification.

AN account of one of the most interesting and instructive experiences in water purification and filtration we have recently seen recorded is contained in an article entitled "Removal of Iron from Water from a Filter Gallery at Reading, Mass.," the text and illustrations of which occupy about nine columns of *Engineering News* (Nov. 26). It affords a view of a struggle with extraordinary conditions and a final triumph over all difficulties, supplying a clear, sparkling, and good water, where formerly only a fetid, discolored fluid, unfitted for domestic purposes, was obtainable. In some cases this water was as dark as beer, and in nearly all cases its odor was disgusting. A very curious phenomenon was observed; water delivered in two adjacent houses would often differ widely in quality on the same day; and even in one and the same house a notable difference in quality of water drawn simultaneously from different pipes was apparent. The cause of this peculiarity was finally traced to differences in the material of the pipes themselves. The water was contaminated with sulphate of iron, and reacted differently upon the pipes, according to peculiarities in the metal of which they were made.

In April, May, and June, the water was colorless. After the first of July it became colored, ranging from 0.02 in December to 0.40 in August (average 0.13), and falling to 0.04 in November, in which month the heaviest sediment deposited. Not only were the variations such as above indicated during a single year, but in 1892 the average of color rose to 0.44, being zero in January and 0.80 in December. In 1893 the color average was 0.64. The odor is variously described as having been "faintly moldy," "unpleasant," "disagreeable." A heavy, rusty deposit, intermingled with partly nitrified organic matter, took place after standing. The water contained scarcely any oxygen, but was charged with offensive gases. Experiments extending over long periods, and made by experts, at last led up to a system of mechanical filtration which has proved effective in rendering exceptionally good a

water which before treatment was exceptionally bad. The system which has effected this notable change comprises the addition of lime (made from marble in northern Vermont, found better than common commercial lime), aeration, coagulation with alum, and mechanical filtration; but this statement by no means gives an adequate idea of details introduced to meet special difficulties, an example of which is the fact that, owing to the changeable character of the water, an hourly test for the quantity of iron in the inflow is made, and both before and after aeration, as well as after coagulation, a test for iron and also for alkalinity is made. There have been few instances of greater difficulties more skilfully met by science in the matter of water-supply, and the results show possibilities in the treatment of water that must be highly reassuring to municipalities now grappling with, perhaps, equally difficult problems. The tables of analyses of filtered and unfiltered water accompanying this article show that the addition of lime increases the carbonate of lime in the water, in parts per 100,000, from 3.80 parts of lime in the unfiltered to 6.40 parts in the filtered water. Costs of details of plant are given, and the article is, as a whole, one of the best in the current literature of water-supply.

The Maxim Steel.

THE statements recently put forth in the *Philadelphia Record* regarding a new steel discovered by Mr. Samuel Maxim, a brother of Mr. Hiram Maxim, the well-known inventor, are such, we should think, as no creditable newspaper would venture to print without some substantial foundation for them. The average daily newspaper often is misled into erroneous statements about mechanical and scientific matters, but it is not apt to quote eminent authorities as endorsing the statements of others, unless it has good reason to believe that denials will not be forthcoming. We certainly hope that all that is told of Mr. Maxim's discovery will prove to be fact; but we shall remain in a wholesome state of skepticism until the stories are fully substantiated. So much has been done in the improvement of steel, and so many announcements of wonderful discoveries by which steel was claimed to gain remarkable properties have come to naught, that even Mr. Maxim would pardon engineers who refused to credit another alleged discovery of the same kind without other evidence than the assertion of a daily newspaper. Meanwhile, it will interest people to know what it is now said that Mr. Maxim has discovered.

Mr. Maxim has an experimental laboratory at Wayne, Maine, and there, it is claimed, he has discovered a process of making steel which he believes identical with the steel of ancient India, alleged to have been far superior in quality to any steel known to modern mechanicians and metallurgists, until its rediscovery at Wayne. It is further alleged that the brothers Maxim are now fitting up a laboratory and manufactory in London for the commercial production of this remarkable metal. For armor-plating it is claimed that the new steel can be made to resist any projectile now known, even when thrown by the highest explosives, and when the plating is thinner and lighter than that now employed.

But that which—if it prove to be well-founded—will be of most interest to readers of this department is the asserted tool-making value of the new steel. "Chisels and drills, made from common iron into steel, through the process discovered by Mr. Maxim, have been submitted to the most celebrated steel-makers of London, who have pronounced them the most wonderful product of modern times. Several drills made from Maxim steel and used by Vickers, Sons & Co., London, steel and iron workers, have been found to withstand marvelous tests. With these tools the best steel known has been drilled, and the drills have not been marred in the least. A small knife blade, made from the Maxim steel, possesses the wonderful power of cutting glass with as much ease as if the glass were chalk."

Now, if all this be true, the world will not long wait for its verification. We repeat the hope that it may be true. It

would be a great addition to mechanical resources to be able to tool ordinary tempered steel or case-hardened surfaces. We once saw a New York mechanic drill a hole through the flat point of a hardened and tempered steel V-point drill. At the time we refused to believe that he did it, as he claimed, with steel of an extraordinary quality, of which he possessed the secret, particularly as we were not permitted to handle the drill with which the feat was performed. We always believed that the tool was armed with diamond dust or bort. Certain it is that results promised at the time never materialized. And other putative discoveries of steel superior to anything ever before known,—have they not occurred about one in a decade, and are they now anywhere visible?

The Siberian Railroad.

OUR esteemed contemporary, *The Railroad Gazette* (Oct. 23), gives a useful list of articles relating to the Siberian Railroad which have appeared from time to time in its columns. To any one who desires to collect the literature of the subject, these articles would be simply indispensable, as from them nearly or quite the entire history of this great enterprise could be compiled. The article containing this list gives a consecutive narrative of some of the more important particulars in the history of the road, which is the latest contribution to the literature of the subject. We shall in this review note only a few points. For a complete summary the article itself should be consulted.

The road was proposed by English capitalists in 1858, and was to connect Moscow with the Straits of Tartary. The proposition was rejected for political reasons. In 1891 it was decided that the road should be built by Russian engineers with Russian capital, and on February 21 of that year Nicolas II inaugurated the enterprise with appropriate ceremonies at Vladivastok.

The road, when completed, will be of a length approached by only the great American transcontinental lines, its total extent being 4,776 miles, "not including the principal branches the main line."

A great many details, which we are compelled to pass with this simple mention, are presented in the article reviewed. Among these is a table of the costs of the various items of construction for each of the seven sections, which will be studied with interest by practical railroad builders and civil engineers. The average total cost per mile, as per this table, is $38,396, estimating the value of the silver rouble at 75 cents in American currency.

The Steel Arch Roof of the Chicago Coliseum.

THE subject of roofs has recently occupied an unusually large amount of space in current architectural and engineering literature. In the American papers the most notable article relating to the subject is an illustrated description of the steel arch roof of the Chicago Coliseum, in *Engineering News* (Nov. 22). The details of this roof, presented in a form sufficiently complete to indicate the principal and most interesting features, are illustrated on a two-page folding inset. Perspective views of exterior and interior are also presented in connection with four or five columns of text.

The building for which this extensive and interesting roof was designed is 675 feet 2 inches long, exclusive of its vestibule, and 300 feet wide in its outside dimensions. Our contemporary compares the span of this roof with that of six other notable roof spans, as follows: The roof of the Manufactures building at the Columbian Exposition, with a span of 368 feet; that of Machinery Hall, Paris Exposition, 1889, 364 feet; that of the Pennsylvania Railroad station at Philadelphia, 300 feet 8 inches; that of the Pennsylvania R. R. station, Jersey City, 252 feet 8 inches; that of the Philadelphia & Reading Railroad, Philadelphia, 259 feet; and that of the Midland Railway station, London, 240 feet.

A more popular idea of the size of the Chicago Coliseum is afforded by a comparison of its holding capacity with that of other large buildings used for popular assemblies. This shows that only one building—St. Peter's at Rome—can ac-

commodate more people. St. Peter's holds 54,000 people, while the Coliseum accommodates 50,000.

Obviously such a notice as this cannot go into the details presented in the illustrations. It may be useful, however, to mention the loads for which the metal work was calculated: Dead load per square foot, 25 pounds; live load, vertical snow and wind, 20 pounds; live load, horizontal wind, 30 pounds. For purlins, dead load, 12 pounds; live load, vertical, 30 pounds. For gallery and roof girders, dead and live loads, 80 pounds. The maximum allowable strains for main trusses were 16,500 pounds per square inch; purlins, 14,500 pounds; and, for gallery and roof girders, 15,000 pounds.

Higher Steam Pressures to be Striven For.

CONTRARY to the views expressed on page 341, November number of this magazine, Mr. J. R. Fothergill, in a paper read before the Northeast Coast Institution of Engineers and Shipbuilders, and printed in the *Journal of the American Society of Naval Engineers* for November, believes that engineers will not be deterred from attempts to reach higher steam pressures on account of inherent difficulties. Some of these difficulties were enumerated in our review on the page named. In support of this opinion he recalls the facts that improvements upon steam engines, particularly marine steam engines, have always been adopted slowly, and only after prolonged trial have proved their value and practicability, and that such a stage of progress has been reached that further increase of fuel economy is hardly conceivable without further increase in working steam pressures. He seems to imply that without such increase a general advance from triple to quadruple expansion engines for marine propulsion is not likely to be made. Then he asks whether we are to stop at one hundred and eighty pounds or at two hundred pounds per square inch, and whether engineers will not push on to a further limit? He himself takes the affirmative side of the question. He argues that at each onward step in the march of progress, from the simple expanding engine up to the triple expansion, each advance being attended with an increase of working pressure, the proposed increase has been met with the same objections based upon difficulties arising from increased temperature. Because these have not hitherto availed to check increase in working pressure, he argues that they will not prevail against further progress in the same direction. Perhaps this may prove correct, and quadruple-expansion engines may become the rule on sea-going vessels, instead of remaining the exception. All the same the objections made to increased pressure were, and still are, valid. They have been met by the addition of increased mechanical resources to the previous stock. But this cannot go on forever. There is a theoretical limit to the gain in power obtainable by a unit consumption of fuel, even were we able to surmount all mechanical difficulties. The trouble is that there is no theoretical limit to the cost of surmounting difficulties; and, when this cost counterbalances the gain in fuel economy, the practical limit of advance has been reached. We repeat that, in our opinion, the limit has been very nearly approached.

THE BRITISH PRESS

A Recently-Developed Industry.

THE Philosophical Society of Glasgow is an association which, in its aims and methods, somewhat resembles the Franklin Institute in Philadelphia. Its transactions for the past year contain, among much other valuable matter, a paper read before the society by A. Humboldt Sexton, professor of metallurgy in Glasgow and West of Scotland Technical College, in which he deals with what the author styles "practically a new industry." The title of Professor Sexton's paper is "The By-Products of the Blast Furnace," and it describes the recovery of these products, in which Messrs. Baird & Co., at their Gartsherrie works in Scotland, made the beginning. Their plant for this purpose was designed by Messrs. Alexander and McCash, who are, therefore, regarded as the pioneers in this industry. It appears, however, that the credit ought to be divided between this engineering firm and the owners of the Gartsherrie works. Of Professor Sexton's paper we will endeavor to make such a summary as will afford the general reader some idea of the rise, extent, and importance of the new industry. The owners of the Gartsherrie works have the credit of being among the most progressive in Scotland. They were the first to adopt the Neilson hot blast in 1830, or thereabouts,—an innovation of inestimable value to Scotch ironmasters,—and their experiment in 1880 has had results scarcely less important. The courage and confidence with which they attacked the problem is worthy of all admiration. The experiment, from its nature, did not admit of cheaply-constructed tentative apparatus, but entailed the erection of a large and costly plant, in many points strikingly analogous to gas works. Professor Sexton states the problem as follows:

"What had to be done was to separate the tar, amounting to about twenty pounds, the ammonia, amounting to about six and one fourth pounds, and a large quantity of water for each ton of coal and 120,000 feet of gas." For this purpose the gas must be cooled from six hundred degrees F. to a temperature at which water will condense. But, when the condensation has been effected, the tar and water assume a vesicular condition and remain suspended in the gas, precisely as fog is suspended in air under favoring conditions. Hence washing the gas by causing it to bubble up through water, or a scrubbing process similar to that carried out in gas-works, became necessary to complete the separation. The works at Gartsherrie use cooling and scrubbing. The plant has been improved, as we shall presently see, but the credit of inaugurating a successful industry is not the less due to the pioneers above named. The plant at Gartsherrie was first designed to deal with sixty million cubic feet of gas per day of twenty-four hours. Perhaps it ought to be here explained to lay readers that the operation of a blast furnace is continuous, sometimes extending night and day through a period of years, or until repairs are needed. Everything that goes into a blast furnace, except the blast, is in a solid state, and everything except the blast goes in at the top. All (except a negligible quantity of dust) comes out either in a liquid or a gaseous condition, the fused solid materials running out at the bottom. The Scotch furnaces are considerably lower than those in the Cleveland district, because the coal they are obliged to use will not sustain sufficient weight to allow greater height. Some of the Cleveland furnaces are one hundred feet in height. Scotch furnaces are now built about sixty feet high and from twelve to eighteen feet in diameter at the widest part. Now, as what goes into a furnace working continuously must equal in weight what comes out, a furnace making, say, three hundred and fifty tons of iron per week would receive per hour, say, five tons of forty per cent. iron ore, one ton of limestone, three and one-fourth tons of coal con-

taining sixty per cent. of carbon, and about twelve tons of air. Out of this hourly charge the furnace will deliver, say, two tons of pig-iron and something over three tons of slag, and the rest of the total weight put in will pass out in gaseous form; about sixteen and one-fourth tons of gas will be delivered. If the composition of the materials could be exactly known, the exact weights of gaseous and liquid products respectively could be stated. The by-products which the new industry saves are the slag, the gases, tar, and ammonia. The gases—chiefly carbon monoxid, result from enforced imperfect combustion of fuel in the furnaces. They are now utilized as fuel after the water, tar, and ammonia have been separated. About twelve times as much gas is made from a ton of coal in a blast furnace as is made in gas works. In the latter the product results from distillation only, while in the blast furnace there are added the products of the combustion of the coke, and nitrogen from the air-blast. A furnace using eighty tons of coal per day yields more than nine million cubic feet of gas per day. It can now be understood that neither the plant first erected at Gartsherrie (which dealt with the products of eight furnaces) or the business pluck at the bottom of the new enterprise was an insignificant affair. The eight furnaces consumed, each, an average of from sixty to sixty-five tons of coal daily. Incidentally it may be remarked that the output of gas from the Glasgow gas works is daily less than that of two iron furnaces using each eighty tons of coal. When it is reflected that less than twenty years ago all this gaseous product, with its accidental contents, was allowed to go to waste and consume in the outer atmosphere, and when the vast number of iron furnaces in the different countries of the world is also considered, some faint idea of the magnitude and importance of the saving effected may be formed. The plant at Gartsherrie consists of an atmospheric condenser, a water-condenser, scrubbers, and exhausters. The atmospheric condenser is a system of tubes into which the gas is conducted at a temperature of about four hundred degrees F. and is cooled in its passage through them down to about one hundred and twenty degrees. Some tar is deposited in these tubes. The gas is then passed on to the water-condenser, an iron chamber forty-five feet both in length and height and eighteen feet in width. Here it is brought into contact with an immense cooling pipe, surface water being circulated through the pipes, and the gas, as it cools, passing over surfaces still cooler, till it has been cooled sufficiently to precipitate its water and tar, which assume the vesicular state above mentioned. It is then passed into the scrubber, a tower eighty feet high crossed by perforated sloping shelves. The gas enters at the bottom, and, passing up through the shelves and their perforations, is met by a descending shower of water, which carries down the substances it is desired to remove. To help the gas in overcoming the frictional resistance of the long and tortuous passage through the entire apparatus, exhausting fans or other forms of exhausting apparatus are employed. Root's blowers are commonly used. The gas is now fit for fuel, and it can be used either for steam generation or directly in gas engines. As already mentioned, this apparatus has been improved somewhat, but the general principle of separating accidental products and utilizing them by condensation is used in all the plants so far erected. The improvements are principally confined to details of construction and order of proceeding,—for example, washing before passing the gas into the atmospheric condenser, etc.

The tar yields lucigen oil and creosote oil, and the slag is made into paving blocks. The value of the by-products is estimated at about one-sixth of the value of the pig-iron out-put.

Welsh Anthracite Pig Iron.

UNDER the title, "Recollections of the Anthracite Pig-Iron Industry," Mr. E. Roberts contributes to the *Iron and Coal Trades Review* (Nov. 20) an article of more than ordinary interest. In it he alludes to the great furnaces of Yniscedwyn in Wales, once famous for their anthracite pig iron. The manufacture of anthracite

g iron in Wales is now practically extinct. Should it ever be revived, the experience of Mr. G. H. Strick of the Amman Iron Works, near Swansea, as recorded in a series of articles printed in the *Iron and Coal Trades Review* in August and September last, will be of value. These articles described the manufacture, the furnaces, and the product. Mr. Roberts declares that Mr. Strick is the greatest living authority on the subject, and that he possesses a knowledge of the industry, gained by practice and experience, combined with technical skill, such as no other man possesses. He was the last to manufacture this iron in Wales, the industry having ceased in 1891. The Yniscedwyn works, with which Mr. Roberts was connected for many years, having been mentioned by Mr. Strick in his articles, Mr. Roberts asserts that Mr. David Thomas, formerly of Yniscedwyn, was the great pioneer of the American anthracite coal trade. An interesting incident anent the differences in quality between the Welsh and American anthracites is related. The master moulder at Yniscedwyn, having spent some time in the Crane Anthracite Iron Works at Cattasauga, Penn., and thus being familiar with the use of anthracite for iron-smelting, was requested to use the Welsh anthracite for the same purpose. To this request he answered that, while the Welsh anthracite was the better coal, "it was different from the American, especially in one particular,—namely, that the Welsh anthracite went to pieces in the cupola when heated, while the American held together, like coke." It is regarded as somewhat remarkable that a man who possessed no technical knowledge should have so sagaciously hit upon the vital fact that the adhesiveness of American anthracite coal contributes largely to its value as a smelting fuel under burden, while the Welsh coal, not possessing this quality to the same extent, although showing better results upon analysis, is less fitted for use in smelting. Mr. Thomas, above referred to, is quoted as authority for doubting that Welsh anthracite was used by itself for smelting prior to 1860. Mr. Thomas commenced its use admixed with coke as early as 1820. He then used one part of the anthracite in from twelve to twenty parts of coke; but he says that, "whenever anything went wrong with the furnace, the fault was laid upon the coal, and the men became so prejudiced against it that I had to give up. He continued to experiment, however, till 1825, in which year he had a small furnace built, and, after blowing it in with coke, he introduced anthracite, in gradually-increasing quantity. But it had to be abandoned on account of the filling up of the tuyeres. A furnace with a larger (eleven feet) back and a twenty-five-foot stack succeeded better, but was still unprofitable. About this time Mr. Thomas heard of the Neilson patented system of hot blast, and became anxious to introduce it in the Yniscedwyn furnaces.

To convince his employer, Mr. George Crane,—then owner of the Yniscedwyn works,—that this would be a good thing, he resorted to the following expedient. "He sought an interview with Mr. Crane in his house, and, while discussing the subject at the fireside, began to blow the fire with a pair of bellows. 'Don't do that, David, or you will put the fire out,' interposed Mr. Crane. 'If the air in those bellows was only as hot as Mr. Neilson describes his hot blast to be,' rejoined Mr. Thomas, 'the anthracite coal in that grate would burn like pine wood.'" This answer is said to have had the desired effect upon Mr. Crane. At any rate, Mr. Thomas was commissioned to investigate the system, and to obtain a license to use it in the Yniscedwyn furnaces, and, in 1837, a new furnace employing the hot blast was successfully blown in at these works.

In this furnace an anthracite iron was profitably made for many years. The introduction of the Siemens-Martin steel for the manufacture of tinplates in 1875—superseding puddled iron for this purpose—struck a death blow to the manufacture of anthracite iron in Wales. Strick, however, stuck to it till 1891. All tinplates now made in Wales are made from steel.

English Railway Accidents.

TRANSPORT has an interesting review of the board of trade statistics as to railway accidents in the United Kingdom in 1895, and finds, as a "first lesson," that "travelling in a railway carriage is just about as safe as walking down the street."

Taking the first statement presented,—"that only 5 persons lose their lives from causes that were beyond their own control during the entire year," while "the injured numbered 399,"—the conclusion might be formed that it was far safer than walking down the street, or even remaining quietly at home; for the total number of passenger journeys, exclusive of those by season-ticket-holders, was 929,770,909.

Such a record would be more than marvellous; and it is not at all surprising, therefore, to find that the item of 5 killed and 399 injured is only the first in a much more extensive railway death-list. It is immediately followed, in the abstracted table, by "accidents from other causes, including accidents from their own want of caution or misconduct," which caused 78 deaths and 710 non-fatal injuries. In addition, 65 persons were killed and 33 injured while crossing railways at grade; 285 "trespassers" were killed, and 144 injured; there were 96 successful attempts at suicide; and "miscellaneous" causes add 53 to the death-roll and 81 to the injury-roll.

These are all exclusive of employees or "servants of companies and contractors," of whom 12 were killed and 88 injured "from accidents to trains, rolling-stock, permanant way, etc.," and 430 killed and 2,566 injured "by accidents from other causes," including their own fault or negligence.

And still the list is not complete, for "the companies have returned 66 persons killed and 5,297 injured from accidents that occurred on their premises, but which were not connected with the movement of railway vehicles."

This swells the total casualty list to 1,090 deaths and 9,318 cases of injury, conveying a very different impression from the one given by the opening sentence. An extraordinary feature is the very large number of accidents occurring on railway premises, but "not connected with the movement of railway vehicles"; another interesting peculiarity is the extremely large percentage of fatal results in the cases of grade-crossers, trespassers, and would-be suicides.

The showing is, on the whole, an excellent one, and is most strongly to be recommended to the attention of our American roads. Unfortunately the comparison of the proportion of injuries to employees, which we expressed the desire to make in the October issue of THE ENGINEERING MAGAZINE, is not immediately possible, as the total number of employees is nowhere given. The total number of reported accidents to employees seems small,—442 fatal and 2,654 non-fatal,—even if we add the entire number of mysterious persons injured on railway premises, but not by the movement of railway vehicles. Supposing them all to be employees, it would give but 508 deaths and 7,951 injuries, while the figures in the United States for the year ending June 30, 1895, were 1,811 killed and 25,696 injured out of a total of 785,034 persons employed.

Examination of the English returns, however, forces the conclusion that they are so classified as to convey an impression unduly favorable to the companies, though this probably is entirely undesigned. For instance, among the employees suffering from "accidents from other causes, including accidents from their own want of caution or misconduct," there were 16 killed and 31 injured while coupling or uncoupling cars; 94 killed and 1,127 injured in other switching operations; 12 killed and 64 injured by being caught between cars; 9 killed and 54 injured by being caught between trains and platforms; 80 killed and 95 injured while working on permanent way or sidings; and 93 killed and 148 injured while walking, crossing, or standing on the line on duty,—nearly three-fourths of the number of casualties grouped under this head, strongly suggesting "contributory negligence," being thus directly traceable to the hazards of duty.

Finally, and (sad to say) in striking con-

trast with American figures for the same items, it is reported that 99 per cent. of signal and point levers throughout the United Kingdom are interlocked, and 94 per cent. of all vehicles in use have brakes complying with some or all of the board of trade requirements.

Management of Water Backing Through House-Drains.

WE illustrate herewith an arrangement for the management of water backing through house-drains into cellars, which is liable to occur in low and flat towns, and to generate an intolerable nuisance. The method was designed and carried out in Croydon, England, by Mr. T. Walker, an engineer of that town. The description of it was first printed in *The Surveyor, London*, whence it has been copied into *Domestic Engineering* (October). The method seems simple and feasible, and worthy of a place among appliances for the sanitation of dwellings.

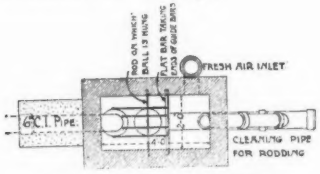


FIG. 1. PLAN OF MAN HOLE.

Fig. 1 shows the plan and Fig. 2 the sectional elevation of a man-hole chamber, receiving the drainage of four houses, through a 6-inch cast-iron pipe, delivering downwards; it is arranged to receive a stout rubber ball, fastened to a chain and arranged so as to find a seat at the mouth of the trap when water backs up through the sewer. The ball is lifted by the water, and forced by guide bars to its seat. These guide bars are shown in detail in Fig. 3.

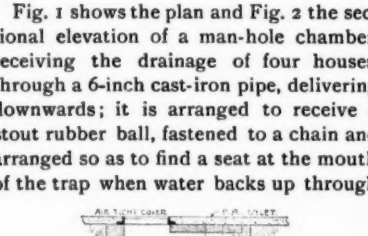


FIG. 2. SECTION OF MAN HOLE.

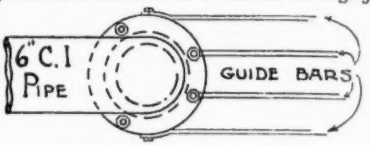


FIG. 3. DETAIL OF GUIDE BARS.

Fig. 4 shows the position of the ball when raised. No further description is needed to explain the action. The chamber receives all the back water, while the drainage acquiring a small head in the house-drain will force its way past the rubber ball-valve and into the chamber, passing

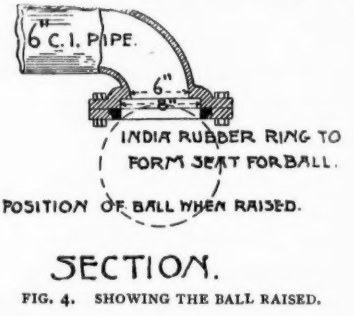


FIG. 4. SHOWING THE BALL RAISED.

thence into the sewer. Of course proper care must be exercised in constructing the chamber, or cistern, which should be proof against leaking; otherwise there will simply be the substitution of one nuisance for another.

Idle Electric Currents.

THE multiplication of technical terms seems to be a fad with some writers on electricity. A new term can not be objected to when it exactly supplies a need in expression, or even when it gives us a better facility for conveying ideas than has been previously possessed; but, when there is no such need, and all a new term can have to its credit is its novelty, we think the practice of word-invention should be condemned. Such an apparently unnecessary term, "wattless," is used in an article in *The Electrical Review* (London, Nov. 20). What is expressed by the term "wattless currents" that is not as

well expressed in the term "idle currents" used in the title, we fail to perceive, even when we carefully scan the definition given by the writer. "A wattless current," he says, "is a current having *the same periodic time* as the electromotive force, but differing in phase by a quarter of a period. This definition," he explains, "excludes currents of a different periodic time—higher harmonics of the useful current which neither contribute to the energy developed by the useful current, nor have the deleterious effects of the wattless current." Exactly so, but what more do we know, or can we know, about these currents by calling them wattless, than by calling them "witless"? We know that these idle currents "do not in any way contribute to the distribution of energy," but the term "wattless" does not seem to help us to this knowledge any more than the term "horse-powerless heat" would aid us to understand that heat radiating from a boiler, steam-pipes, and steam engine cylinders inside and outside does not contribute to the desired distribution of mechanical energy. But, waiving this criticism of what we think a superfluous technical term, we pass to a criticism which the writer of the article makes upon a paper read by M. Blondel at the Congrès International des Electriciens, Geneva, 1896, which is that, in that discussion of the question, M. Blondel disregarded altogether "the convenience of the consumer" . . . "in stating that the lagging current is all-important," and considered "merely the economy and ease of the conduct of the supply station." The position is taken by the *Electrical Review* critic that, "provided the consumer uses a watt-meter or an erg-meter, the presence of a wattless component of the current is usually of small importance to him, so long as the heating effect is not excessive." The critic admits that the regulation of generators is rendered extremely difficult when there is a large lagging current, but calls attention to the fact that, when "there are alternating synchronous motors on the distributing mains, a leading current will interfere with their regulation." It is urged that a lagging current weakens the field of a generator and strengthens the field of a motor, while a leading current weakens the field of a motor and strengthens the field of a generator. Therefore leading currents should be considered of importance as well as lagging currents. Idle, or wattless, currents are characterized as "perhaps the greatest difficulty in the distribution of electrical energy by alternating currents, the lagging currents acting deleteriously upon the regulation of the generators at the central station, and increasing the heating of the circuit." M. Blondel's critic admits, however, that "the regulation of the generators is the more important, since they have to supply current for lighting purposes as well as for motive power"; but, if any synchronous motors be on the circuit, the leading current becomes a factor whereby the fields of such motors are weakened and their load-limits diminished. The aim should be to "have the current in phase with the generator E. M. F.," without which neither the supply company or the consumer can be pleased. The article concludes with the opinion that the suppression of these idle currents may be reached (as believed by M. Blondel) by possible improvements in generators and motors, such suppression being "one of the most important problems in electro-technology."

The Navies of England, France, and Russia.

A PARLIAMENTARY return of the fleets of the chief naval powers presented to the house of commons during its last session, but only recently printed and published, furnishes material for a well-prepared review in *The Engineer* (London, Nov. 13). The fleets of Great Britain, France, Russia, Germany, Italy, and the United States are classified in the report as follows: (1) battle-ships built and building; (2) cruisers built and building; (3) coast-defence ships; (4) torpedo vessels, catchers, and boats. In our contemporary's review of this report the second class is considered as consisting of cruisers and protected cruisers. Of armored battle-ships, England has forty-five afloat and twelve

building,—a total of fifty-seven. Sixteen of these battle-ships have heavy armaments of muzzle-loading guns. France has twenty-nine battle-ships floating and six building. Russia has ten battle-ships afloat and nine now building. The Russian and French fleets, afloat and building, and armed with breech-loaders, would, if combined, outnumber the British ships similarly armed, showing fifty-three to Great Britain's forty-one, and, counting those armed with muzzle-loaders, the combined Russian and French fleets equal the entire British fleet. From these facts *The Engineer* enters upon some curious calculations, in which the question of the strength of fleets is considered wholly from a mechanical standpoint, "the man behind the gun" being left entirely unconsidered. "A ship's power of artillery attack is considered as proportional to her total energy of fire per minute." It is also figured out that the tonnage of the British battle-ships is thirty-one twenty-fifths as much as the combined tonnage of the Russian and French fleets. *The Engineer* assumes it to be certain that the Russian and French fleets would act together in case of a European war, and, as their combined strength appears to be about equal to that of the British fleet, this condition is regarded as serious, and is so discussed. The armored cruisers of England, Russia, and France are next considered. Of these, Great Britain has eighteen, with a total displacement of 137,050 tons; France has ten, including one now building, with a total displacement of 60,716 tons; and Russia has, afloat and now building, eleven, with a total displacement of 82,273 tons. Combined, the cruiser fleets of France and Russia are distinctly stronger than the cruiser fleet of England. At the same time England is very strong in protected cruisers, of which she has afloat and under construction one hundred and sixteen, while France has thirty-seven and Russia only two. Of these our contemporary remarks that "among English ships of this class are some very powerful vessels, including the Powerful and Terrible, each of 14,000 tons, and four of the Diadem class building, of 11,000 tons. These vessels are practically more strongly protected than most armored cruisers." Of coast-defence armored ships England has fourteen, while France has fourteen and Russia sixteen. England has thirty-five torpedo vessels; Russia has sixteen and France thirteen. England has one hundred and one torpedo boats as against two hundred and twenty French and one hundred and sixty-two Russian. Of torpedo-boat destroyers England has built and building ninety-one. It almost takes one's breath away, after thus surveying the vast naval power of Great Britain, to hear it urged that it must be further increased; but this is precisely what our contemporary says must be done. In case of war "England would hope so to keep the sea as not to need large numbers of coast-defence ships and small torpedo boats. England, probably, on the whole, stands at least as well, compared with France and Russia as she has at any time for many years past; nevertheless, with the relations now existing between France and Russia, it is of vital consequence that she should be strong at sea, and for this cause a forward decided naval policy should be followed." From this it is indicated that Great Britain can not feel safe with a naval power less than that of such nations as are likely to combine their fleets in event of war. Hence, in a protracted time of peace, preparations for war are actively kept up in British dock-yards, and there is no indication when and where this will end. The one phase of this activity that can be regarded with unmixed satisfaction is the fact that all this ship-building, armoring, and arming provides an enormous amount of work for a worthy class of mechanics.

Breakdowns of Stationary Steam Engines.

AN experience of twenty years in the inspection and insurance of steam engines ought to afford opportunities for collecting a large store of information upon the subject of faults in construction and defects leading to breakdowns. It is from such an experience that Mr. Michael Longridge, of Manchester, England, draws in a paper with the above title, printed in *The Colliery Guardian* (Nov. 13), and read

before the Institution of Mechanical Engineers November 5, 1896. The paper is largely statistical, and, in such a notice as the present, some of its most salient points only can be dealt with. The statistics are compiled from a list of the last one thousand breakdowns with which the author had to deal prior to 1895. While this number is, perhaps, too small to be accepted as a basis from which to draw general conclusions, it is certainly large enough to afford very fair ideas of breakdowns of stationary engines in English practice. A running commentary of hints relating to causes of breakages and means of avoiding them accompanies the tables, and the paper is in every sense a valuable contribution to the current literature of mechanical engineering. The breakdowns are classified. One table pertains to parts which appear to have broken first. Out of the one-thousand breakdowns this table shows that of valves and valve-gear there were 213; of spur wheels, 124; of air-pump motions, 121; of air-pump buckets and valves, 88; of columns, entablatures, bedplates, and pedestals, 86: of main shafts, 89; connecting-rods, 41; cylinders and valve-chests, 35; parallel motions, 35; governors and governor-gears, 28; piston rods, 27; piston-rod cross-heads, 27; pistons, 22; links, 22; fly-wheels, 19; air pumps and condensers, 13; cranks, 12; gudgeons in beams, 12; crank pins, 11; beams, 6; slide bars, 5; ropes, 3.

Lastly, the list is rounded up with an engine that, like the famous "one-horse shay," went to entire smash, but, unlike that admirable vehicle, instead of being made equally strong in every part, appears to have had a uniformly-distributed weakness. No other cause for this complete smash was ascertained. This preliminary table is followed by another, which gives the total number of breakdowns of valve gear, and the number of breakdowns due to specific and well-ascertained causes. Thus 46 valve-spindles were broken,—34 on account of weakness of screw threads, and 12 from sundry causes not named. Of eccentric straps there were 24 breakages, 8 of which were due to weakness, leaving 16 unaccounted for specifically. So on through the list of 213. Of the 124 spur-gearing breakages; 23 were due to back lash from belt or rope drums on "second-motion" shafts; 19 were attributed to vibration caused by high speed, heavy load, insufficient fly-wheel, and small pinions; 16 were from excessive stress due to teeth bearing on their corners and up to their points; and 11 are assigned to high speed and irregular pitch. Bolts or pieces of broken teeth getting between the wheels caused 10 breakages. The rest of these wheel breakages were due to a variety of causes, some of which were not ascertained. It is explained that the term "backlash" is used by Mr. Longridge in the sense understood in Yorkshire and Lancashire, England, "which includes not only backlash proper, but also break of contact between the working faces of the teeth of the two wheels when the driven wheel runs faster than the driver." What is called the "second motion" shaft, in Lancashire, is a shaft carrying a pinion geared with the driving wheel.

Mr. Longridge deprecates as dangerous the practice of placing rope or belt drums of any considerable size on shafts driven by spur-gearing, explaining why it is dangerous. "Such drums" (in England) "are often put upon second-motion shafts to replace existing gearing or to drive additional machinery. As they have generally to be got into existing buildings where there is little room to spare, there is often a temptation to keep down their width and run them at high circumferential speed. This alone is sufficient to make the pinion on the second-motion shaft overrun the spur-wheel on the main shaft of the engine; but, when, in addition, the ropes or belts bounce, as they sometimes do if long, unless the engine has a powerful fly-wheel the effect is sure to be disastrous to the gearing. In fact, it may be safely stated that heavy rope- or belt-driving should never be placed in sequence to spur-gearing, except after special investigation by a competent engineer fully aware of the risk incurred." The nineteen wheels the breakage of which is ascribed—as above stated—to vibration were really broken on

account of a kind of wear and tear, which Mr. Longridge thinks peculiar to large segmental rim spur-gears, as they were all of this kind, and, except in a single instance, transmitted 1,000 or more. The author says it is impossible to describe in detail the causes of this destructive jar, but from his description, it appears to arise from imperfect workmanship, more particularly in the form of the teeth, which in most cases appear to have been machine-molded. He therefore advises the avoidance of wheels of this design under conditions of high power and velocity ratio.

Portland Cement Admixtures.

CERTAIN admixtures of ground stone, slag, etc., with Portland cement having been claimed not to injure, but, on the contrary, to actually improve, its quality, Mr. D. B. Butler, at the conclusion of a paper read by him in 1895 before the (British) Society of Engineers, declined to express an opinion as to whether or not this claim could be sustained. He stated that he was at that time prosecuting a series of experiments upon the subject, the results of which would enable him to speak to the point with greater certainty, and that for this reason he would then reserve his opinion. At the meeting of the society held November 2, 1896, he presented the results of the experiments in tabulated form, together with photographs of sections of concrete made with cement containing slag, clinker, and Kentish ragstone, the latter having been claimed by one cement manufacturer to be an actual improvement, and as such improperly called an adulterant. "Kentish rag" is a local name for a sandy limestone . . . extensively quarried near Maidstone, England, and elsewhere, and used for building and road-making. The paper describing the experiments and their results in *The Engineer* (Nov. 6) does not present the tables, but states in a general way some of the peculiarities of such admixtures. The rag-stone used in the tests was analyzed, and found to contain: water, 1 part; insoluble siliceous matter, 7.28 parts; soluble silica, 2.75 parts; alumina, 3.7 parts; oxid of iron, 3.34 parts; carbonate of lime, 80.69 parts; carbonate of magnesia, 0.56 parts. These numbers amount to a fraction more than 100 parts, but we give them as tabulated in *The Engineer*. Rag-stone purchased at a Maidstone quarry was ground to a fineness which left a residue of 31 per cent. on a 180 sieve, 25 per cent. on a 120 sieve, 9.8 per cent. on a 76 sieve, and 3 per cent. on a 50 sieve. This stone was then added to ordinary Portland cement in quantities ranging from 2 to 50 per cent., and the tensile strength was tested in the usual manner, at dates ranging from seven days to twelve months. When gaged neat, the admixture did not seem to materially affect the strength, some specimens seeming to indicate a slight gain, especially at the earlier dates; but, when gaged with three parts of standard sand, the adulterated cement gave a lower result than the pure cement in nearly all cases. When 15 per cent. of ragstone was added, it was found that the injurious effect was much intensified when the cement was left entirely in the air, and also when it was exposed to sea-water. Fifteen per cent. of the ragstone was used, because this proportion was about that recommended by the advocates of ragstone. This admixture was further tested in comparison with cements made by three other manufacturers, tests of two of which cements were carried to three months only, while the third was carried to the end of twelve months. These tests confirm the results of the other experiments. When tested neat, the admixture showed no material effect upon the strength, except that in some instances a distinct gain was manifested. But, when tested as a mortar with three parts of standard sand, the strength was reduced from 6 to 14 per cent. The ultimate conclusion arrived at, is, that any admixture of inert materials not readily soluble in water, "or reduced to an absolutely impalpable powder, so that it can be acted upon by every particle of the cement," lessens the cementitious value, and becomes a source of weakness. Methods of detecting the presence of these foreign substances are also dealt with. The author strongly recommends the microscope as an invaluable aid thereto.

FRENCH AND GERMAN PRESS.

We take pleasure in announcing that, beginning with this number of the magazine, we have arranged to comprehensively review, and to add to the index, the leading articles in all the important French and German industrial periodicals.

Owing to the necessary delays and formalities of effecting so many exchanges, the work in this direction is not yet as full as it will shortly be. Its speedy completion will place at the command of our readers practically the entire range of the technical literature of the world, and will make the REVIEW AND INDEX OF THE ENGINEERING MAGAZINE the most elaborate and exhaustive work of its kind which has ever been attempted.

Germany's Electrical Progress.

Mr. SCHEFFLER, the chairman at the opening of the winter session of the "Elektrotechnische Verein," reviewed, as usual, the progress of the past year. The number of lamps connected to the various central stations has been increased by about twenty per cent, while the supply of power has been increased since the last publication of central-station statistics by 7,336 kilowatts, which corresponds approximately to 150,000 normal lamps. A point of greater value to the community, however, is the considerable decrease in price to the consumer. While in some places 50 pfennigs (12½ cents) are charged per k.w.h., up to 400 k.w.h., the charge for power above that number is but 2 pfennigs per k.w.h. Thus real advantage is gained only if the consumers utilize current for other than lighting purposes. The central station thus offers inducements for day loads, being enabled to run stations at a more uniform load.

In mining and in the running of machinery for general heavy work, electricity has proven itself a most valuable agent during the past few months. The Salt mine, "Luneburg," is an excellent example, since the rope drives which worked the pumps have been replaced by dynamos and motors driven from an engine. Although the amount of coal used is not more than it was in former years, the company can run 12 h.-p. motors for their workshop and 500 incandescent lamps.

The ship of Emperor William, "Aegir," has been electrically equipped.

Possibly much of the financial success of some of the electrical roads is due to the fact that lighting and power stations are run together. In Germany this appears to be an indisputable fact, while in the United States this has not always shown itself desirable. Electrical control of switches is now an accomplished fact. Entire streets can be so arranged that an accident happening to any one car will bring all the cars immediately to a standstill.

The utilization of the 500–600–volt direct current has been constantly increasing; in fact, the activity in electric railroad construction in Germany is steadily growing. The fact that but 872 kilometers are at present in existence, while 855 kilometers are at present in course of construction, is sufficient evidence for this statement. Even in railroad work the rotary current is finding favor, to which the Lugano (Switzerland) road bears witness.

The lighting of the mail-cars by electricity is another step in advance. Accumulators are used throughout, and fifty per cent. of the mail-cars—that is, about 800 in all—have been fitted.

The rotary current has been freely introduced of late, on account of the ease with which motors may be run. The "Drehstrom" motors are distinguished by the absence of brushes, thus making their maintenance easy. The only trouble—which up to the present is intrinsic in this class of machinery—is the great loss of power in the regulating devices. Special attention should be devoted to the important problem of absolutely non-synchronous motors.

The utilization of water-falls has made considerable progress during the past twelve months. and the works at Rheinfelden, for 15,000 h. p. with 6,800 volts, deserves special mention. The culm is now being made use of for the first time, the firm of Siemens & Halske constructing a plant at Johannesburg which trans-

mits energy through a distance of 45 kilometers. Another of 25 kilometers in length is being put in operation in Upper Silesia.

Dynamos whose total capacity amounts to several thousand horse power have been put in operation for the electro-mechanical industry.

Investigations of the last few years show that large networks of electrical conductors tend to weaken the violent action of thunderstorms, and to decrease the danger from lightning.

A number of large stations have replaced their batteries by accumulators. The total length of the telegraph lines has increased from 144,638 to 150,906 kilometers, and that of telephone lines from 643,743 to 709,211 kilometers.

Mining and Metallurgy in Upper Silesia.

THE real basis of the Silesian industries is the mineral wealth of the region. It contains principally zinc, lead, iron ore, and coal. Coal is found not only near, but in many cases with, or in strateral layers above or below, the minerals. Without this easy access to coal neither the iron industry or metallurgical works could exist. The total area occupied by these large coal-fields amounts to about 5,600 square kilometers. Dr. Fr. G. Bremme, who recently delivered a lecture before the "Verein Deutscher Eisenhüttenleute" (Society of German Iron Miners and Metallurgists), explained in detail the position and condition of the principal veins of iron ore and coal throughout that country, showing ease of access as well as convenience in transportation.

The quality of the coal found in the central region is extraordinarily pure, the amount of ash being very low. The quantity of sulphur found usually does not exceed one per cent. For the coking process, however, the country is not in good condition. Out of 18,000,000 tons produced in 1895 but 2,000,000 tons were of the fat and open-burning coal. Of the so-called fat coal 1,580,000 tons were turned over to the coke establishments, the remainder, 420,000 tons, going to the gas plants. The utilization of non-coking coal for coal-dust-brick (briquettes) is effected only in two installations. The most important fat coal in Silesia is composed of the following elements: carbon, 79.57 per cent.; hydrogen, 5.01 per cent.; oxygen, 9.48 per cent.; nitrogen, 1.10 per cent.; sulphur, 80 per cent.; ash, 4.84 per cent. In the blast furnaces in 1895 1,241,000 tons of ore were melted. The total production of pig iron is 568,000 tons. Eleven works, with twenty-six furnaces, are in operation. The record of production for one furnace for one day is 110 tons. Several works remove their slag with locomotives, while but a few years ago horses and even men did this work. Gas-firing has, in several places, been successfully introduced. The author concludes with a reference to the conditions of the working classes in the neighborhood. In the Silesian district 103,245 people are employed, of whom 66,348 work at coal and ore mining, 9,539 in zinc, lead, silver, and allied works, and 27,358 in the iron and steel industry. Of the employees 11,500 are women. In this densely-populated district there is little demand for household duties, and most of the female employees are girls or widows. The salaries paid to men, women, and boys under sixteen years of age were, for the past year, as follows: men, 788.51 marks=$147; women, 322.60 marks=$80.60; boys, 319.24 marks=$79.81.

Longitudinal Sleepers in Austria.

FROM a paper on "Permanent Way" read before the International Railway Congress by W. Hohenegger, and printed in the August number of the *Bulletin of the Congress, The Railway Review* (Oct. 31) reprints an account of experiments made with longitudinal sleepers, "undertaken on account of the difficulty of holding the track in position on sharp curves when the speeds of trains were increased." The curves of some of the sections of the road whereon the experiments were made comprise fifty per cent. of the whole line.

The form decided upon for the experiments employed two lateral flanges made of wrought iron. Two and one-half miles were laid in 1876. The length of the sleepers in this experiment was 31 feet 10

inches, the weight being 52 pounds per yard. At the joints of the sleepers cross-tie supports were used, which were similar in section to the longitudinal sleepers. The rail weighed 54 pounds per yard, and at intervals of 32 feet two tie bars were passed through the webs, but these were afterward removed. The cross-ties soon gave place to lighter angle irons, on account of the oscillations which were imparted to the cars by the stiff ties. The total weight of this track construction was 250 pounds per yard, and the cost was about $5 per yard more than that of the ordinary construction on wooden ties. This trough construction has been in use on a section of track along the Danube for twenty years, and now requires renewal on account of wear."

In relaying, a system employing stronger rails and sleepers was adopted. But of the results of the twenty years' experiment with the sleepers above mentioned the following particulars are presented.

During the whole twenty years of the first experiment there has not been a fracture of a sleeper or an actual rail fracture on either of the two experimental sections, while, on the adjoining sections laid with wooden ties, the rails had to be replaced after from twelve to fifteen years' service. The rails on the longitudinal system have already lasted twenty years without exhibiting any material damage at the joints.

"The price of the structure, when made of piled wrought iron, was high, and, on account of having a large number of weldable Scotch iron rails on hand, an experiment was made with longitudinal troughs made of the old rails, which were welded together at the head and rolled into the desired trough section. Thirteen miles of this form of support was put into service between 1877 and 1880, the cost being approximately the same with this construction as with the wooden sleepers. In this construction, the length of a trough could be made up to a length of sixteen feet, the cost being about $5.20 per yard of permanent way. In the experiment angle irons were used as cross-ties. The rails weighed fifty-four pounds, and, as the experimental section is now considerably worn, it is being removed and relaid on the cross-tie system." Attention is also directed to the great advantage of iron longitudinal sleepers as compared with wooden ones; for, while wooden longitudinal sleepers would have become utterly useless, by decay or mechanical destruction, in the course of twenty years, the iron sleepers are still so well preserved as to be likely to last another twenty years in the station sidings, where the running is slow. Wooden sleepers would probably have to be renewed throughout at the end of fifteen or twenty years, including most of the fastenings; whereas, in the case of the iron permanent way,—the first cost of which is not materially more than that of the other,—nearly all the parts can be used over again.

The Latest Discoveries at Tungad.

ALBERT BALLU, chief architect of the Algerian monuments, states in a report that extremely valuable work has been accomplished during the past year at Tungad (Algiers). Judging by the excavations made, which offer an opportunity of investigating the construction of buildings and roads, the time of destruction can be determined within two centuries. It has been found that one house usually stood on a piece of ground of about four hundred square meters in area. The complete report appeared in *L'Ami des Monuments*, No. 55, vol. 10.

An Underground Road in Budapest.

AUSTRIA-HUNGARY has long been preeminent for progressiveness in mechanics, particularly in the exploitation and adaptation of the newer inventions and discoveries.

Indeed, the people of the double empire have been called the "Yankees of Europe," and from present indications they seem to more than deserve their pseudonym. We are so accustomed to believe in our unapproachable supremacy in the inventive and mechanical world that we are in some danger of sleeping on our laurels; witness our strange inattention to the horseless carriage and the water-tube boiler. And there are some hints that Austro-Hunga-

rian developments in the electrical field might profitably be watched by us.

But now comes the news that, while we are yet struggling with the idea of an underground road, as if it were an unheard-of and doubtful proposal, Budapest is celebrating the opening of an electric underground line two and a quarter miles long, following for the most part the line of Andrassy street, "the most beautiful thoroughfare in Budapest," and that "the public has taken favorably to this road, a fact largely due doubtless to its smooth and noiseless working and very neat equipment."

The following notes are taken from the *Electrical World*.

"The road is 3¼ kilometers long (2¼ miles), of which 3.22 kilometers consist of tunnel and .53 of a kilometer surface road, and has walls one inch thick finished with beton. It is 3¼ meters deep, measured from the surface of the street. The inner clear height is 2.65 meters and the clear width 6 meters, thus leaving sufficient room for both tracks and for the necessary iron columns which support the upper portion of the tunnel. The largest grade is one in fifty, and the sharpest curves have a radius of 40 meters. The road is double track of standard width, and is provided with loops at both ends. Drain pipes run under each track for the purpose of carrying off all water which may collect in the tunnel. The top of the tunnel is constructed of iron and beton, the I-beams being held together by means of bolts and screws. The columns carrying the roof are four meters apart, and rest on foundations of beton.

"On the top of the columns, and running lengthwise with the tunnel, are two I-beams each 320 (milli?) meters deep when supporting a wooden pavement above, and 350 (milli?) meters deep when supporting a stone pavement. These beams also aid in supporting transverse I-beams placed one meter apart, the opposite ends of which rest on the side walls of the tunnel. These transverse beams vary in height according to the required carrying capacity, and they are either 300, 320, or 350 millimeters deep. The intervening spaces between the cross-beams are filled with beton, an extra layer of which increases to 10 centimeters in thickness, and is put in for the purpose of obtaining a slight curvature on the pavement above. The whole tunnel is completely surrounded by layers of asphaltum-felt plate for the purpose of making it completely water-tight. Gas and water pipes which were met with during the process of construction were partly run below the rails and partly alongside the tunnel."

The stations, which are about 300 meters apart, are described as generally similar to those of the London underground, with platforms serving trains in one direction only. There are no platforms between the tracks. The power-house has four boilers "with combined heating surface of 268 square meters, and two sets of engines of 600 horse-power each, driving multipolar generators."

The equipment at present consists of twenty motor cars and ten trailers; the cost of the road is given as about $1,250,000.

Fenders For Electric Street Cars.

THE city of Hamburg has appointed a committee of prominent engineers to investigate the question of fenders. The conclusions these gentlemen have arrived at are not by any means encouraging; in fact, they find, after investigating every European fender as well as one hundred and thirty-three of the principal American fenders, that no adequate system has as yet been proposed. The chief point brought out in the argument is that almost every fender requires the personal attention of the motorman, whereby the usual personal equation is added to the already difficult problem. For the motorman to appreciate the danger, to put his hand to the particular device, and to work the same will take more time than would ordinarily be practicable. If the fenders are too near the ground, they are apt to strike in case of the car getting into a state of vibration. Should they be too high, the person whom it is intended to save may be most seriously hurt, as he is liable to be crushed in addition to being run over.

Utilization of Refuse.

BUDAPEST, one of the most progressive cities on the European continent, owes not a little of its prosperity to the strict enforcement of its sanitary rules. The city has made a contract, dating from January 1, 1896, with Mr. Ludwig v. Cséry, in which the latter party guarantees to remove all city refuse within closed carts to the suburbs. The method of transportation as well as of utilization being unique, we give the following details: The wagons are conveyed by horses to one of the suburbs, where they are lifted off the truck and put on a flat car by means of a traveling crane. This flat car is taken out a considerable distance by a steam locomotive and lands the refuse near a manufacturing establishment, where it is mechanically assorted and the more volatile material burned under a boiler which supplies fifty h. p. to an engine, to which a 3,000-volt three-phase generator is directly coupled. The electric current thus generated is utilized to run the crane above mentioned, and is transmitted to that point by means of two regular trolley wires, with the earth as a third circuit. The machinery in this station runs several other power circuits, and furnishes light to the entire colony. The *Elektrotechnische Zeitschrift* (Oct. 15) states that another 100-h. p. engine will be installed shortly.

Annual Report of Zurich Electricity Works.

AFTER the completion of the electric installation, the management turned its attention to the equalizing of the load line. This was effectively accomplished by an accumulator sub-station. Since the consumption of electric energy rose within one year to such an extent that even the reserve machines had to be called into service, the company is under negotiation for an additional 600-h. p. generator set. Additional accumulator sub-stations will also be erected.

With the present amount of machinery, the plant is capable of developing 5,256,000 kilowatt-hours, while actually 918,095 kilowatt-hours, or 16 per cent., were furnished. Four per cent. were utilized for excitation of the generators. Between the current indicated at the switchboard and that paid for and recorded at the consumer's premises a loss of 29 per cent. was noted. This is considered to be principally due to transformer losses.

Considering lamps and motors used by private consumers in terms of lamp-equivalents, it was found that, under an average generation of 729 kilowatt, 466,963 kilowatt-hours were consumed. This shows an average utilization of 590 hours per lamp per year, or about 1 hour and 36 minutes per lamp per day. It is interesting to note in this connection that the average utilization of every lamp connected to the Edison system in New York City is about 1 hour and 15 minutes per 24 hours. It might be mentioned that the *Elektrotechnische Zeitschrift* of October 22 gives additional data from the Zurich station annual report.

Electrolysis Due to Trolley Currents.

IN a very careful manner this subject is treated by Mr. A. Monmerqué in a concluding article in *L'Eclairage Electrique* (Oct. 10). The English board of trade has established a rule that but five volts drop shall be allowed in the return circuit. This the author believes to be an unnecessary rule, since each case requires special attention; for example, it is not essential to prevent earth currents if no pipes run parallel to the rails and if not too many pipes are crossing. Rails being used for a return, their electrical as well as mechanical resistance should be examined. This precaution in the beginning will, in many cases, make additional copper return unnecessary, as the rails alone, if well bonded, will have sufficiently low resistance.

Among the problems to which the electrical engineer should devote special attention may be mentioned these: experimental determination of the value of the different systems for bonding rails, with a view to maintaining high conductivity; the resistance of the soil under different conditions; value of building rails on an isolated foundation; practical results obtained with the three-wire system.

Iron Industry in France during the first half-year of 1896.

The following, compiled from the *Comité des Forges de France*, will be of interest to many:

1. PIG IRON.

	1st Half-year '96.	'95.
Puddled iron.....	893,909 tons	763,942
Foundry pig and cast iron.....	252,685	228,482
Total.....	1,146,594	992,424

The total production is 15.5 per cent. greater for this year than that for the same period last year.

2. WELDED IRON.

Rails	417	181
Commercial iron....	347,885	340,584
Sheet iron.....	43,364	51,011
Total.....	391,666	391,776

3. STEEL.

Bessemer.....	338,436
Martin.....	199,811
	538,247

This is, in total, 129,558 tons more than was produced during the corresponding period of 1895.

Aluminum on Warships.

EXPERIMENTS at the imperial navy yards at Wilhelmshafen have shown conclusively that aluminum cannot be used practically in men-of-war construction, while aluminum bronze has turned out satisfactorily in many cases, when the alloy contained 94-96 per cent. of aluminum and 6-4 per cent. copper. After investigating and testing aluminum in certain parts of vessels, the following conclusions were arrived at. Aluminum bronze is useless for bearings, valves, etc., on account of the rapid wearing away; it has been found useful, however, for various parts of machines where friction is not an important factor, and also in cases where light weight is an object. Furniture made of aluminum showed decidedly too little resistance and required frequent repainting, aluminum shows, furthermore, but little resistance to sea-water, thus making it useless for the walls of vessels. A 10 per cent. aluminum bronze, however, stands a fair chance of being freely used as soon as the price of aluminum can be sufficiently reduced to approach the value of cast steel.

A Century of German Coke Blast-furnaces.

ON September 21, 1796,—that is, one hundred years ago,—the first coke blast-furnace was put into successful operation. On November 10, 1796, the first practical coke pig iron was turned out, and the furnace remained fired for twenty-four weeks. Mr. Fritz W. Lürmann, who delivered an address on the above subject before the annual meeting of the German Iron Miners, gives details of all the following furnaces, which, after the first successful experiment, followed with considerable rapidity. It is interesting to note the constant increase in size.:

Year.	Name and Place of Furnace.	Height mm.	Furnace top mm.	Upper part of boshes mm.	Width of Hearth mm.	Contents. cbm.
1796	Gleiwitz.....	12,900	1250	3450	800/600	49.83
1804–1808	Königshütte.....	13,300	1220	3660	915/585	51.91
1834	Bayner Hütte, with air blast.	10,690	1045	2825	785/497	29.49
1840	Königshütte.....	15,240	1830	4270	815/355	104.04
1850	Königshütte.....	15,605	1880	4700	1255/785	112.64
1853	Hörde	16,065	3140	5020	1250/945	169.24
1855	Haslinghausen	14.130	2825	4920	2200	176.88
1865	Ilseder Hütte..	17.445	3800	5000	1886	208.59
1860–1870	Königshütte.....	15 535	3765	4920	33000/2197	207.02
1867	Georg-Marien Hütte.....	17.108	4184	5178	2196	219.10
1876	Gutehoffnungs Hütte.....	21,000	3400	5500	2100	293.45
1886	Hörde.....	19,150	3500	6000	2500	325.50
1888	First coke oven with free hearth.....	23,000	4050	6[illegible],000	3100	431.03

German Mining Salaries.

TO the statistics published in *Zeitschr. für das Berg, Hütten und Salinenwesen* on the quantities of various materials mined during the first half of this year, there is attached a list of salaries paid to the miners in the principal sections of Germany. It shows, on an average, a net earning 2.13 marks per day, or 53 cents in American money.

THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED.

Age of Steel, The *w.* $3. St. Louis.
American Architect, The *w.* $6. Boston.
American Electrician. *m.* $1. New York.
Am. Engineer and Railroad Journal. *m.* $2. N.Y.
American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
American Journal of Sociology. *b-m.* $2 Chicago.
American Machinist. *w.* $3. New York.
American Magazine of Civics. *m.* $3. New York.
Am. Manufacturer and Iron World. *w.* $4. Pittsburg.
American Shipbuilder. *w.* $2. New York.
Am. Soc. of Irrigation Engineers. *qr.* $4. Denver.
Am. Soc. of Mechanical Engineers. *m.* New York.
Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
Architect, The. *w.* 26*s.* London.
Architectural Record. *q.* $1. New York.
Architectural Review. *s-q.* $5. Boston.
Architecture and Building. *w.* $4 New York.
Arena, The *m.* $5. Boston.
Australian Mining Standard. *w.* 30*s.* Sydney.
Baker's Railway Magazine. *m.* $2. N. Y.
Bankers' Magazine. *m.* $5. New York.
Bankers' Magazine. *m.* 18*s.* London.
Bankers' Magazine of Australia. *m.* $3. Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* 26 marks. Berlin
Board of Trade Journal. *m.* 6*s.* London.
Boston Journal of Commerce. *w.* $3. Boston.
Bradstreet's. *w.* $5. New York.
Brick Builder, The *m.* $2.50. Boston.
British Architect, The. *w.* 23*s.* 8*d.* London.
Builder, The. *w.* 26*s.* London.
Bulletin Am. Iron and Steel Asso. *w.* $4. Phila.
Bulletin of the Univ. of Wisconsin, Madison.
California Architect. *m.* $3. San Francisco.
Canadian Architect. *m.* $2. Toronto.
Canadian Electrical News. *m.* $1. Toronto.
Canadian Engineer. *m.* $1. Montreal.
Canadian Mining Review. *m.* $3. Ottawa.
Century Magazine. *m.* $4. New York.
Chautauquan, The *m.* $2. Meadville, Pa.
Colliery Engineer. *m.* $2. Scranton, Pa.
Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London
Dingler's Polytechnisches Journal. *w.* 43.60 marks. Stuttgart.
Domestic Engineering. *m.* $2. Chicago.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.
Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Elektrotechnische Zeitschrift. *w.* 25 marks. Berlin.
Elektrotechnischer Anzeiger. *s-w.* 10 marks. Berlin.
Engineer, The. *s-m.* $2. New York.
Engineer, The. *w.* 36*s.* London.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.

Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J.
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Gunton's Magazine. *m.* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta.
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal Franklin Institute. *m.* $5. Phila.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Kansas University Quarterly. *qr.* $2. Lawrence, Kan.
L'Eclairage Electrique. 60 fr. Paris.
L'Électricien. *w.* 25 fr. Paris.
Le Génie Civil. *w.* 45 fr. Paris.
Locomotive Engineering. *m.* $2. New York.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m.* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Mining and Sci. Press. *w.* $3. San Francisco.
Mining Industry and Review. *w.* $2. Denver.
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8*s.* London.
Municipal Engineering. *m.* $2. Indianapolis.
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York.
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of Civ. Engs. *yr.* 50 cts. La Fayette, Ind.
Progressive Age. *s-m.* $3. New York.
Railroad Car Journal. *m.* $1. New York.
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York.
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stahl und Eisen. *s-m.* 20 marks. Dusseldorf.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Assn. Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Railway Club, Pro. Chicago.
Wisconsin Engineer. *yr.* Madison, Wis.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.
Zeitschrift für Elektrochemie. *s-m.* 16 marks. Halle, a. S.
Zeitschrift für Elektrotechnik. *s-m.* 20 marks. Vienna.
Zeitschrift für Instrumentenkunde. *m.* 20 marks. Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

9184. The Great Scaffolds of the Congressional Library, Washington, D. C. (Brief illustrated description of this beautiful building, with cuts showing the method adopted for giving access to the interior surface of the dome). Sci Am—Nov. 14. 900 w. 15 cts.

9203. The Steel Arch Roof for the Chicago Coliseum (Illustrated description of a steel roof of great magnitude. General arrangement, composition and some details are given). Eng News—Nov. 12. 1800 w. 15 cts.

9278. The Youngstown, O., Bank Building (Illustrated description of a handsome building of fireproof construction). Eng Rec—Nov. 14. 2800 w. 15 cts.

9332. The Influence of Steel Construction and Plate Glass Upon Style. Dankmar Adler (One of the series of papers on this subject read before the A. I. A., at Nashville, Tenn. Denies that the art of architecture ended with the Renaissance; denies that new materials and processes are incompatible with truly artistic work; thinks the influence of the new materials will tend to a more free treatment of architectural design). Arch & Build—Nov. 21. 2700 w. 15 cts.

9345. Roof Coverings—Slates. Thomas Stirling, Jr. (Read before the British Arch. Assn. An extract relating to the Westmoreland and Cumberland slates). Brit Arch—Nov. 13. 3800 w. 30 cts.

9346. Roof Coverings — Tiles. F. Walker (Read before the British Arch. Assn. On the selection and setting of tiles used for roof coverings). Brit Arch—Nov. 13. Serial. 1st part. 2000 w. 30 cts.

9362. Copper, Lead and Zinc as Materials for Roofing. G. Ewart (Read before the British Arch. Assn. Advantages of sheet metal over slate and tiles are presented, and a comparison of the claims of each of the three metals). Arch, Lond—Nov. 13. 3000 w. 30 cts.

9439. The Influence of Steel Construction and of Plate Glass on the Development of Modern Style. G. F. Newton (One of the series on this subject read before the Am. Inst. of Arch's at Nashville, Tenn. Defends the high building, and thinks the effect of these new materials on style must depend largely upon the instinct and artistic training of the architect). Arch & Build—Nov. 28. 1800 w. 15 cts.

9443. Revolving Palace for the Exposition of 1900 (Brief illustrated description of novelty suggested for the French exposition, credited to M. Charles Devic). W. Elec—Nov. 28. 700 w. 15 cts.

9450. The New Edinburgh Fever Hospital (Brief description of some of the principal buildings of a new hospital for the treatment of infectious diseases). Arch, Lond—Nov. 20. 2000 w. 30 cts.

9461. Deep and Difficult Bridge and Building Foundations. George E. Thomas (Extracts from a paper read before the W. Soc. of Engs. Briefly refers to difficult work accomplished by caissons, the freezing plan and pile-driving). Am Arch—Nov. 28. 2000 w. 15 cts.

9489. New York's Great Movement for Housing Reform (An account of the project for improving the dwellings of the poor, with illustrations of the noted men who are supporting the movement and plans of the model dwellings). Rev of Rev—Dec. 6500 w. 30 cts.

9553. The Central Armory, Cleveland, O. (General description, elevations, longitudinal section, transverse sections, features of construction, plumbing, heating and ventilating are given in part first). Eng Rec—Dec. 5. Serial. 1st part. 1100 w. 15 cts.

9607. The Central Penitentiary for the Province of Posen in Wronke. (Das Centralgefangniss fur die Provinz Posen.) (Details of plans with many diagrammatical illustrations). Zeitschrift fur Bauwesen. No. X-XII. 2700 w.

9626. Statics of Structures—Theoretical and Applied. O. F. Semsch (An investigation of the conditions under which the forces acting upon any body will be in equilibrium. Part first treats of the simple beam with uniform load). Am Arch—Dec. 5. 2000 w. 15 cts.

9627. The Planning and Construction of High Office Buildings. William H. Birkmire (Part first discusses the transformation in building construction methods, the cause of the development, with general introductory remarks and many illustrations). Arch & Build—Dec. 5. Serial. 1st part. 1500 w. 15 cts.

9638. Cathedral at Granada and Its Architect (Die Kathedrale von Granada und ihr Baumeister). Carl Justi (One of the largest and best constructed churches of the 15th century). Zeitschr. fur Christi Kunst. No. 7 and 8. 1896. 6000 w.

HEATING AND VENTILATION.

9318. Heating and Ventilation of the Buffalo Real Estate Exchange (Illustrated description of apparatus designed in connection with the designing of the building, and which is a decidedly great improvement on the usual custom). Heat & Ven—Nov. 15. 2500 w. 15 cts.

9319. Friction of Water in Hot Water Heating Pipes. J. H. Kinealy (Investigations which the writer has made in order to fix upon the proper formulae to be used in determining the friction in the pipes of hot water heating systems). Heat & Ven—Nov. 15. 700 w. 15 cts.

9381. Heating and Ventilation. Warren C. Weatherly (General discussion of subject). San Plumb—Nov. 15. 2000 w. 15 cts.

9554. Heating of a Prison Mess Hall and Hospital (Brief illustrated description of building added at Sing Sing prison). Eng Rec—Dec. 5. 300 w. 15 cts.

9605. Heating and Ventilation in the New Reichstag Building at Berlin. (Die Heizung und Luftung im neuen Reichstaggebaude.) (Statement of the requirements, and details of the final installation). Weiner Bauindustrie Zeitung. Oct. 29, 1896. 1800 w.

LANDSCAPE GARDENING.

9477. Parks and Roads. J. F. Foster (Discusses the requirements of an attractive park, the construction, preparation of the ground, designing of necessary structures, construction of walks and roads, &c.). Jour of W Soc of Engs. Oct. 8000 w. 45 cts.

9478. Parks and Park Roads. H. C. Alexander (The most important salient points are discussed, confined mostly to Lincoln Park, Chicago. Followed by discussion). Jour of W Soc of Engs. Oct. 6000 w. 45 cts.

9524. Botanic Gardens. D. T. Macdougal (Treats of the origin and general organization, with illustrations). Pop Sci M. Dec. 4000 w. 45 cts.

9580. Garden Design. F. Inigo Thomas (Read before the British Arch. Assn. Historical review of the treatment of the garden and its relation to architecture, with description of effective sites and the principles of development of garden design. Followed by discussion). Builder—Nov. 28. 9500 w. 30 cts.

PLUMBING AND GASFITTING.

9191. Proper Care of Plumbing Apparatus (Rules prepared by the Plumbing Inspector and Engineer of an American city, for the purpose of showing the citizens the necessity of proper care and management of plumbing apparatus). Plumb & Dec—Nov. 2. 1100 w. 30 cts.

9192. Improved Methods of Drainage Construction. E. C. Lynde (Explains best methods of making socket joints, drain traps and the construction of branch drains, tools required, &c.). Plumb & Dec—Nov. 2. 2000 w. 30 cts.

9243. Plumbing Simplified. William Paul Gerhard (Drawings illustrating a simplified method are given, with discussion of the subject). Arch & Build—Nov. 14. 1800 w. 15 cts.

9279. Some experiments in Interior Illumination. Carter J. Page, Jr. (Read before the Am. Gas Lgt Assn. Investigations of the difference between the loss in candle power of a source of light with and without globes of various densities. Also discussion). Am. Gas Lgt Jour. Nov. 16. 6000 w. 15 cts.

9287. Sanitary Plumbing. Albert E. Hyde (Written for the American edition of the Encyclopedia Britannica. Its relation to the health of the people, with a discussion of house drainage and ventilation of pipes, house water supply and fixtures). Dom Engng. Nov. 1800 w. 30 cts.

9288. German Plumbing. Robert Grimshaw (How plumbing is done in Germany. Information from personal observation and interviews, text books and illustrated catalogues of dealers). Dom. Engng. Nov. Serial. 1st part. 1500 w. 30 cts.

9382. Laying Water Mains. J. H. Decker (Common sense remarks on the various branches of the subject.) San Plumb—Nov. 15. 2000 w. 15 cts.

9485. Material and Tools for Main and Service Laying. E. H. Millard (Read before the England Gas Managers' Assn. Gives experience and results in the practice of the writer; describes and illustrates by diagrams some appliances found useful). Pro Age—Dec. 1. 2500 w. 15 cts.

9630. Service Pipes and Service Piping. T. Littlehales. Coating Service Pipes. A. C. Humphreys (Two short papers read at the meeting of Am. Gas Light Assn. with discussion and illustrations). Am Gas-Light Jour—Dec. 7. 3800 w. 15 cts.

MISCELLANY.

9158. Fire-Proof Construction and Recent Tests. Ill. A. L. A. Himmelwright (Describing the tests of fire-proof qualities lately made by the New York Department of Buildings). Eng Mag—Dec. 3900 w. 30 cts.

9380. Architecture in the University. S. H. Capper (Lecture to the students of McGill University, Montreal. Its right to a place in the curriculum; the general topic of art; the scope of architecture, &c.). Can Arch & Build—Nov. 6000 w. 30 cts.

9400. Prof. Aitchison's Address Before the Royal Institute of British Architects (Defines the position of architecture and reviews the various great epochs of the art, showing what should be considered the duty of architects). Jour Roy Inst of Brit Arch—Nov. 5. 9500 w. 45 cts.

9415. High Buildings and Safe Elevators (An editorial discussion of the recent accident in the American Tract Society

Building, and its importance to those interested in high buildings and their construction). Eng News—Nov. 26. 2500 w. 15 cts.

9419. Rustless Coatings for Iron and Steel. M. P. Wood (Causes of corrosion and protection needed; the danger threatening high buildings of metallic construction, bridges, &c. Examples of remarkable character). Am Soc of Mech Engs—Dec. 3300 w. 45 cts.

9434. Report of Progress of the Committee on Fireproofing Tests (Illustrated report of progress made by a joint committee to the several bodies which created these committees). Am Soc of Mech Engs—Dec. 2000 w. 45 cts.

9435. The Mechanical Plant, Horticultural Hall, Philadelphia (A description, with floor plans, giving special attention to the heating, ventilation and lighting arrangements). Eng Rec—Nov. 28. 2300 w. 15 cts.

9446. Some Experiences of Modern Fireproofing Material in Actual Tests. Peter B. Wight (It is the purpose of the article to give descriptions of incipient fires in fireproof buildings of the best class, with reliable data). Br Build—Nov. Serial. 1st part. 1800 w. 30 cts.

9449. Iffley Church (Information obtained by the Oxford Architectural and Historical Society on a recent visit. Deals more with the history than the architecture). Arch, Lond—Nov. 20. 2400 w. 30 cts.

9476. Notes on Bedford Stone, Louisville Cement and Other Things (A symposium of information gathered on an excursion to these industries, followed by dission. Illustrations). Jour of W Soc of Engs—Oct. 1650 w. 45 cts.

9525. Animal Symbolism in Ecclesiastical Architecture. Andrew D. White (A very interesting review of book by E. P. Evans on this subject). Pop Sci M—Dec. 3800 w. 45 cts.

9541. Against High Buildings (Regarding proposed legislation on the subject, with expressions of opinions from several insurance and real estate men). Fire and Water—Dec. 5. 1400 w. 15 cts.

9559. High Buildings and Safe Elevators (Portions of letters to the editor called forth by the recent editorial on this subject). Eng News. Dec. 3. 2200 w. 15 cts.

9579. Architecture of Italy in the Dark Ages (Illustrated review of the English version of Raffaele Cattaneo's "Architecture in Italy from the Sixth to the Eleventh Century"). Builder—Nov. 28. 4300 w. 30 cts.

9581. An Ideal Architect. Archibald Dunn (Address delivered before the Northern Arch. Assn. The writer's conception of an ideal architect, considering what he must be and know). Arch, Lond—Nov. 27. 2700 w. 30 cts.

9582. The Frescoes of the Sixtine Chapel. W. B. Richmond (Lectures delivered at the Alexandra College, Dublin. Gives a biographical sketch of the painter, Michael Angelo Buonarotti; describes the construction, and pictures). Arch, Lond—Nov. 27. 4000 w. 30 cts.

9602. Action of Refrigerating Plant of the Slaughter-House in Cologne (Die Leistung der Kuhlanlage des stadtischen schlachthofes zu Koln). R. Schlottler (Description of the plant with methods used). Zeitschrift des Vereines Deutscher Ingenieure. Oct. 10, 1896. 3500 w.

9606. Testing Instrument for Foundations (Fundamentprufer) (An instrument devised by Rudolph Mayer. By means of a spring the pressure which will counteract the ground at any point is determined. Wiener Bauindustrie Zeitung. Oct. 22, 1896. 1400 w.

9608. The Decoration in Paris During the Franco-Russian Festivities (La Decoration de Paris pendant les fetes Franco-Russes) (Short description of the principal decorations of the public buildings during that time). L'Architecture. Oct. 10, 1896. 700 w.

CIVIL ENGINEERING.

BRIDGES.

9187. A Concrete Arch Bridge of Forty Feet Span (Illustrated description of concrete highway bridge of forty feet span built across Richmond Creek, Belleville, Ill.). Sci Am Sup—Nov. 14. 600 w. 15 cts.

9397. Counterweighted Lift Bridge on the Erie Railroad (Description with perspective view of bridge across Berry's Creek, near Rutherford, N. J.). Sci Am—Nov. 28. 600 w. 15 cts.

9412. A Novel Lift Bridge on the Erie (Illustrated detailed description of the bridge over Berry's Creek, about seven miles from Jersey City). R R Gaz—Nov. 27. 2500 w. 15 cts.

9482. Bridge Practice (Discusses whether it is permissible in good practice to erect structures in which it is impossible to estimate, after a year's working, the maximum strains in the different bars). Engng—Nov. 20. 1300 w. 30 cts.

9557. The Accuracy of the Ordinary Formulas for Swing Bridges. F. E. Turneaure (The discussion considers truss

bridges only, and examines the formulas for continuous girder with constant moment of inertia, pointing out an easy method for determining the degree of approximation in any given case, and of correcting the computations if desired). Eng News—Dec. 3. 2300 w. 15 cts.

9571. Replacing a Main Line Railway Bridge in 150 Minutes (Illustrated description of a remarkable piece of bridge-building and removal on the Great Northern Railway at Peterborough). Eng, Lond—Nov. 27. 1800 w. 30 cts.

9595. The Operating Mechanism of the New Rock Island Bridge (Describes the swinging machinery proper, rail locks, the end jacks, interlocking and controlling systems and controlling device). Am Eng & R R Jour—Dec. 1300 w. 30 cts.

9609. The Iron Bridge Over the Otterthal (Die eiserne Thalbrucke uber des Otterthal) (Ernst Biedermann, of Berlin, gives detailed description of this bridge, which is built on the American type of scaffolding bridges, a method especially applicable in this particular instance). Zeitschrift fur Bauwesen. No. X-XII. 4900 w.

9615. The Kornhaus Bridge in Berne (Die Kornhaus bruke in Bern). By H. V. Linden (All the details of this bridge, from the development of the project to its final construction are presented. The bridge is supported by an arch across the river and built on the ordinary girder plan on land). Schweizeriscke Bauzeitung. Oct. 17, 1896. Serial. 1st part. 6300 w.

CANALS, RIVERS AND HARBORS.

9246. Deepening the Thames (From the London Times. Describes an improvement that will affect the navigable channels of the river between Gravesend and the Nore). Arch, Lond—Nov. 6. 1200 w. 30 cts.

9323. A Survey of a Great Lakes and Hudson River Ship Canal (A presentation of the principal facts and a discussion of the results, as based on data from report by Albert J. Heines. No great accuracy is claimed for the estimater. The editor's views regarding the construction of a ship canal from the Great Lakes to the Atlantic Ocean are given briefly). Eng News—Nov. 19. 1800 w. 15 cts.

9384. New York Harbor and Trade (Editorial comment on the improvements needed in the harbor and the amount of trade passing this port, with the need of effort to keep it from drifting to other seaports). Trans—Nov. 13. 1600 w. 30 cts.

9545. The Improvement of the Channel of the Delaware River. Walter Atlee (Illustrated description of improvements already made. Followed by discussion). Jour Fr Inst—Dec. 11000 w. 45 cts.

IRRIGATION.

9301. The Irrigation of Arid Lands. J. J. Miller (Deals with the artificial means of making arid lands profitable). Yale Sci M—Nov. 2000 w. 30 cts.

9398. Possibilities of Irrigation in Montana. S. B. Robbins (Claims 20,000,000 acres of arable land in the State which could be profitably irrigated. Reviews the advantages and the conditions). W Min Wld—Nov. 21. 2000 w. 15 cts.

9497. A Problem of Aridity. C. M. Harger (The situation in the West, decrease in value of property and serious conditions to be met by the people of the semi-arid regions). N Am Rev—Dec. 1700 w. 45 cts.

9555. The Mt. Nebo Reservoir and Canal System, Utah. W. P. Hardesty (Illustrated description of the construction work). Eng News—Dec. 3. 3000 w. 15 cts.

9558. The Ownership and Control of Water in the Irrigated West (Discusses some of the broader phases which are intimately connected with the character of irrigation works). Eng News—Dec. 3. 2000 w. 15 cts.

9560. The Measurement of Water for Irrigation. J. B. Pope (An attempt to demonstrate the importance of abolishing the "miner's inch" and adopting cubic feet per second as a unit of measurement for all water systems. Tables, carefully calculated and their correctness demonstrated, are given with explanations). Eng News—Dec. 3. 3500 w. 15 cts.

MISCELLANY.

9209. Presidential Address of J. Wolfe Barry before the Institution of Civil Engineers, London (An interesting retrospective survey of the general progress with which engineering is intimately connected, especially during Queen Victoria's reign, with other subjects of interest). Eng, Lond—Nov. 6. Serial 1st part. 6000 w. 30 cts.

9211. The Effect of Admixtures of Kentish Ragstone, &c., upon Portland Cement. D. B. Butler (Abstract of paper read before the Soc. of Engs., London. Illustrated description of experiments by the writer, with results and conclusions). Eng, Lond—Nov. 6. 2800 w. 30 cts.

9309. Rocks Suitable for Road-Making. U. S. Shaler (Brief discussion of varieties and their fitness and unfitness for road-making). Stone—Nov. 700 w. 30 cts.

9324. The Application of Photography to Surveying (Abstract from a paper by John S. Dennis, of Ottawa, Can., read before the Denver meeting of the Am. Soc. of Irrigation Engs. The principle of the method). Eng News—Nov. 19. 1000 w. 15 cts.

9333. The New Shore Road in Brooklyn, N. Y. (An account of a proposed drive which when completed promises to be one of the most attractive in the world). Eng Rec—Nov 21. 1000 w. 15 cts.

9404. The Proper Profile for Resisting Wave Action. Robert Fletcher (Abstract of a paper filed in the library of this society. A continuation of previous study of the subject by the writer). Am Soc of Civ Engs—Nov. 2800 w. $1.

9499. Development of the American Portland Cement Industry. Frederick H. Lewis (Considers the conditions which prevail in manufacturing, in using, and in testing cements in this country, and discusses the course which it is advisable to follow in dealing with cements). Munic Engng—Dec. Serial. 1st part. 1100 w. 30 cts.

9500. Forms of Clip and Briquet for Tensile Tests of Cement. L. C. Sabin (The form of briquet recommended by the committee of the Am. Soc. of Civ. Engs was used in the tests described, with various styles of clips) Munic Engng—Dec. Serial. 1st part. 1400 w. 30 cts.

9556. The Sinking of a Wharf at St John, N. B. (Account taken from the Daily Sun and Daily Telegraph, of St. John, N. B.). Eng. News—Dec. 3. 1300 w. 15 cts.

9569. Practice with Science (Abstract of a Presidential address delivered by Mr. Henry McLaren before the Yorkshire College Engineering Society. Chap I. deals with the practical man; Chap II. with the scientific man, and Chap. III with the man who combines practice with science). Engng—Nov. 27. 6000 w. 30 cts

ELECTRICITY.

ELECTRO-CHEMISTRY AND METALLURGY.

9170. On the Specific Gravity and Electrical Conductivity of the Normal Solutions of Sodium and Potassium Hydroxides and Hydrochloric, Sulphuric, Nitric and Oxalic Acids. E. H. Loomis (A measure of the specific gravity and electrical conductivity of various solutions whose preparations are described). Phys Rev—Nov.-Dec. 900 w. 45 cts.

9257. Electricity as Applied to Metallurgy. Prof. Threlfall (Brief history, both theoretical and practical). Aust Min Stand—Sept. 6500 w. 30 cts.

9493. Electricity in Gold Milling. H. M. Chance (A classification of the numerous methods by which it has been proposed to use electricity for this purpose. Followed by discussion). Pro Engs' Club of Phila—Nov. 2500 w. 45 cts.

9514. The Action in the Jacques Carbon Cell. C. J. Reed (Comment on the theories advanced). Elec Eng—Dec. 2. 1000 w.

9601. Method for Electrolytically Desilverizing Lead (Procede de Desargentation electrolytique des plombs argentiferes). By D. Tommasi (Value of constructing a factory for the purpose and the principle on which the process is based). L'Eclairage Electrique. Oct. 17, 1896. Serial. 1st part. 4200 w.

LIGHTING.

9157. Are Electric Central Stations Doomed? Max Osterberg (Showing how isolated plants may be economical in electric-lighting). Eng Mag—Dec. 1900 w. 30 cts.

9178. Studies in the Spectrum of Reflection. Dr. W. H. Birchmore (This paper is intended to make clear some obscure points in a previous article published in this paper Sept. 30). Elec Eng—Nov. 11 1300 w. 15 cts.

9200. Electric-Lighting at the People's Palace (Illustrated description of the plant). Elec, Lond—Oct. 23. 2400 w. 30 cts.

9210. The Electric-Lighting of the Theatre of Earl's Court Exhibition (Illustrated description of the arrangement of the lights). Eng, Lond—Nov 6. 1000 w. 30 cts.

9219. The Electric-Lighting of Croydon (Brief illustrated description). Elec Rev. Lond—Nov. 6. 2800 w. 30 cts.

9244. Bury Electricity Works (Illustrated detailed description). Elec Eng Lond—Nov. 6. 3000 w. 30 cts.

9245. Electrical Installations. F. J Warden-Stevens (The author's aim is to place before architects and others information which will prove a source of help when having such matters under consideration. Part first is devoted largely to motive power). Arch, Lond—Nov. 6. Serial. 1st part. 2800 w. 30 cts.

9297. Isolated Lighting and Power Plant at Hearst Haciende, Sunol, Cal. (Illustrated description). Am Electn—Nov 700 w. 15 cts.

9298. Lighting of a Country Residence E. G. Bernard (Illustrated description of a simple system for residence lighting) Am Elect'n—Nov. 1000 w. 15 cts.

9299. Typical Electric Plant for Country Residences. Maurice Barnett (The writer aims to show that electric lighting can be carried on economically in the country, and light be had at any hour of

the day or night without the necessity of running the engine more than a few hours three or four times a week, except when the full capacity of the dynamo is wanted nightly). Am Electn—Nov. 1600 w. 15 cts.

9316. The Carbon Circuit of an Incandescent Lamp. Converse D. Marsh (Discussion, with illustrations of the neglected features which injure the efficiency of lamps. Elec. World—Nov. 21, 900 w. 15 cts.

9317. Tower Wagon for Arc Lamp Trimmers. (Illustrated description). W. Elec—Nov. 21. 600 w. 15 cts.

9351. Leyton Electric Lighting. (Illustrated description of a gas driven installation). Eng, Lond—Nov. 13. 1800 w. 30 cts.

9356. The Development of the Arc Lamp. J. Warren (The writer proposes to describe details of principle and construction in the matter of arc lamps, from the time of their first practical utilization to the present day). Elec, Lond—Oct. 30. Serial, 1st part. 2300 w. 30 cts.

9367. The Hastings Electric Light System (Illustrated description with details of unusual features). Elect'n—Nov. 13. 3500 w. 30 cts.

9383. Manchester Ship Canal Electricity Works (Brief illustrated description of the lighting of the docks). Elec Rev, Lond—Nov. 13. 1800 w. 30 cts.

9392. The New Station of the Southern Electric Light and Power Co., Philadelphia, Pa. (Illustrated description of a complete and extensive plant). Elec Eng—Nov. 25. 900 w. 15 cts.

9408. The Determination of the Quality of a Vacuum by Electrostatic Discharge. Converse D. Marsh (An account of tests of lamps on the American market made under the direction of the writer to determine the quality of the vacuum). Elec Wld—Nov. 28. 1400 w. 15 cts.

9487. Electric Lighting in Cape Town (From report of A. P. Trotter. The work seems to be very inferior and unsatisfactory). Eng, Lond—Nov. 20. 2500 w. 30 cts.

9509. Electric Lighting at Darwen. Report of E. M. Lacey (Gives the probable demand for current, the most suitable system, capital outlay necessary, probable profit, the desirability of combining the electricity works with a system of refuse destructors). Elec Eng, Lond—Nov. 20. 3500 w. 30 cts.

9563. New Physical Phenomena of Röentgen Rays. Charles Lester Leonard (Extract from a paper read before the Am. Phil. Soc. New phenomenon observed with experiments and conclusions). Elec World—Dec. 5. 1200 w. 15 cts.

POWER.

9183. Negative Efficiency. F. A. Halsey (Showing that the possible range of efficiency in machines must be set down to be from minus infinity to plus one). Am. Mach—Nov. 12. 1000 w. 15 cts.

9268. The Siemens & Halske Electric Company of America (Illustrated description). Elec Wld—Nov. 14. Serial, 1st part. 1600 w. 15 cts.

9302. Niagara Falls Power in Buffalo. Stephen L. Coles (An illustrated account of the successful test made at midnight Nov. 15. Brief description of the transmission line and its construction). Elec Rev—Nov. 18. 3000 w. 15 cts.

9313. Niagara Power Transmission Up to Date. Frank C. Perkins (Part first is an illustrated description of the electrical equipment for the Buffalo Street Railway). Elec Wld—Nov. 21 Serial, 1st part. 1200 w. 15 cts.

9314. Synchronous Motor as Compensator in Alternating-Current Distributions. Ernst J. Berg (The article will show how the losses and the compounding of the generator are affected by using a synchronous motor as compensator in an alternating-current system, discuss the general effect of synchronous motors at various power factors of the load, and the most suitable size of synchronous motor to be used and the gain made thereby). Elec Wld—Nov. 21. Serial, 1st part. 2000 w. 15 cts.

9365. Boosting with Alternating Currents. Alexander Russell (Boosting is briefly described, the theory considered and illustrations given). Elect'n—Nov. 13. 1300 w. 30 cts.

9396. Volts vs. Ohms. H. Ward Leonard (Paper presented at meeting of Am. Inst. of Elec. Engs. Speed regulation of electric motors). Elec—Nov. 25. 2800 w. 15 cts.

9451. The Economies of Electric Power Plant. C. C. Longridge (Instances of power economy effected by the use of electricity, calling attention to the mechanical principles on which the economy is based). Min Jour—Nov. 21. 1300 w. 30 cts.

9490. The Electric Storage Battery. Rudolph H. Klauder (Calls attention to the dawning of a new era in electrical station practice in this country. The advantages of accumulators are considered, the situation in this country and in Europe is explained, the practical uses that can be made of the storage battery in generating plants, cost, &c.). Pro Engs' Club of Phila—Nov. 10000 w. 45 cts.

9536. Old Hydraulic Canal Plant at Niagara Falls Transformed for Electrical Transmisssion. Orrin E. Dunlap (Illustrated description of the changes made). W Elec—Dec. 5. 2000 w. 15 cts.

9565. Calculation of Electrical Motors. Alfred E. Wiener (Part first deals with finding the capacity of a generator corresponding to a motor of a given output, and speed calculations of electrical motors). Elec Wld—Dec. 5. 1500 w. 15 cts.

9597. Rotary Transformer. (Transformateur rotatif.) Saturnin Hanappe. (Description of 5 k. w. direct current transformer.) L'Leclairage Electrique—Oct. 17, 1896. 1400 w.

9598. Electromotive Force Produced in a Portion of a Gramme Ring, Moving in a Constant Magnetic Field. (Determination de la force electromotive induite dans une portion d'anneau Gramme tournant dans un champ magnetique uniforme.) By Loppe. (Derivation of formulae.) L'Eclairage Electrique—Oct. 17, 1896. 800 w.

9599. Electric Power in Shops. (Les transmissions electriques dans les ateliers.) A. Hillairet (Registering instruments employed to indicate power used by motors driving saws, drills, planers, &c.). L'Eclairage Electrique—Oct. 17, Nov. 7, 1896. Serial. 1st part. 2100 w.

9600. New Method for Determining Dynamo Efficiency. (Nouvelle Methode pour la Determination des Rendements.) J. L. Rontin. (The Measurements are made with a tachometer only.) L'Eclairage Electrique—Oct. 24, 1896. 1200 w.

9604. Alternating Current Machinery of Ganz & Cie. A. O. Dubsky and P. Girault. (Le Material a courants alternatifs.) (Description of the principal types manufactured by that firm). 1000 w.

9612. Automatic Starting and Stopping Devices for Electric Elevator Service. (Selbstthatige Anlass-und Abstellvorrichtungen fur elektrischen Fahstuhlbetrieb). G. Speiser. (German types and detailed methods of construction). Elektrotechnische Zeitschrift—Oct. 15, 1896. 1000 w.

9613. Electric Power Plant at the Berlin Exposition. (Elektrische Starkstromanlagen auf der Berliner Gewerbeausstellung). Ludwig Mittelmann. (Details of all power and lighting machinery furnished by the different manufacturers). Elektrotechnische Zeitschrift — Oct. 15, 1896. Serial. 1st part 900 w.

9614. Measurement of Earth Resistance in Power Circuits by Means of Line Potential. (Die Messung des Erdwiderstandes von Starkstromanlagen mittels der Betriebsspannung). Dr. Oscar May. (Accompanied by a table of energy losses due to leakage). Elektrotechnische Zeitschrift —Oct. 22, 1896.

9628. On Drehstrom Motors with Reduced Speeds. Hans Gorges in Elek. Zeitsch (Describes a new and interesting phenomenon, which the writer considers only a special case of a much more general group of phenomena, which may have a practical value as well as a theoretical interest). Elec Rev, Lond—Nov. 27. 800 w. 30 cts.

9646. A New Electric Light and Railway Power Station of the Edison Electric Illuminating Co. of Paterson, N. J. (Illustrated, detailed description). Elec Eng—Dec. 9. 4500 w. 15 cts.

TELEPHONY AND TELEGRAPHY.

9175. Underground Telephone Wires in Indianapolis (Illustrated description of the system used). Elec Eng—Nov. 11. 700 w. 15 cts.

9230. Telephone Conduits and Subways. Dr. V. Wietlisbach (Illustrated article treating of simple construction, subways and conduit or duct construction). Elec Engng—Nov. 7000 w. 15 cts.

9266. Insulated Wires and Cables; Their Construction and Design—Insulation; 1st Efficiency and Defects. J. Draper Bishop. (These papers are intended to cover broadly the manufacturing processes of all kinds of cables at present used, as well as the principles governing their design and the value of their insulation electrically. Deep-sea telegraph cables, however, are omitted. Part first considers the commercial side of the question and describes briefly the physical nature and qualities of the various insulating materials). Elec Wld—Nov. 14. Serial. 1st part, 3000 w. 15 cts.

9267. Telephone Repeaters or Relays, and Repeating Systems. Thomas D. Lockwood (Long running comment on newspaper electrical news is followed by the personal views of the writer on the subject given). Elec Wld—Nov. 14. Serial. 1st part. 5500 w. 15 cts.

9296. The Berliner Microphone Patent before the U. S. Supreme Court. (Important arguments, on both sides, with editorial comment). Elec Eng—Nov. 18. 4000 w. 15 cts.

9363.—The Telephone Trunk Line System in Great Britain. J. Gavey (A review of the theoretical principles involved in the erection of balanced telephone circuits). Elec Eng, Lond—Nov. 13. Serial, 1st part. 2500 w. 30 cts.

9395. Casual Notes on the Use of Telephone Election Returns. George Heli Guy (The good work done all over the country, with curious and amusing features). Elec Eng—Nov. 25. 1400 w. 15 cts.

9445. Improvement in Dynamo-Telegraphy. F. P. Medina (The equipment of the Pacific Postal Telegraph Co. in San Francisco is described in part first, and an improvement by which the dynamo quadruplex is being worked with greater efficiency than was attained with chemical batteries). Elec, Lond—Nov. 13. Serial. 1st part. 1500 w. 30 cts.

9513.—Cailho's System of Simultaneous

Telegraphy and Telephony (Description, illustrated by diagrams). Elec Eng—Dec. 6. 800 w. 15 cts.

MISCELLANY.

9168. A Study of the Apparent Capacity of Condensers for Short-Charge Periods. Hubert V. Carpenter (Experiments are described and results discussed). Phys Rev—Nov.-Dec. 1000 w. 45 cts.

9169. Note on the Osmotic Theory of the Voltaic Cell. H. M. Goodwin (A reply to criticism by Mr. Bancroft of results published by the writer). Phys Rev—Nov.-Dec. 1200 w. 45 cts.

9176. Roentgen Ray Apparatus. The Current Interrupter. W. M. Stine (An examination of types of interrupters). Elec Eng—Nov. 11. 1200 w. 15 cts.

9177. Dr. Sheldon on Electrical Measurements of Precision (Synopsis of lecture delivered before the Electrical Department of the Brooklyn Institute. Advance and improvement in methods). Elec Eng—Nov. 11. 700 w. 15 cts.

9179. Mysterious Breakdowns of Insulation. Elihu Thomson (Reference to editorial in issue of Oct. 21 on this subject and calling attention to points that would tend to remove danger). Elec Eng—Nov. 11. 1000 w. 15 cts.

9201. Applications of Electricity. Ellis H. Crapper (Part first is devoted to electrical measurements of high temperatures). Elec, Lond—Oct. 23. Serial. 1st part. 1000 w. 30 cts.

9218. Methods of Charging for Electricity (Illustrated description of the Wright rebate indicated and the ways in which it is used). Elec Rev, Lond—Nov. 6. 2800 w. 30 cts.

9248. Armature Reactions. Alexander Rothert (Abstract of a paper read at the Berlin meeting of the Verband Deutscher Elektrotechniker. A new method for the dimensioning of generators in the use of alternating or polyphase currents, and to account for their mode of action, and especially for the loss of pressure in the cases of inductive and non-inductive loads. Illustrated by diagrams). Elect'n—Nov. 6. 4500 w. 30 cts.

9265. Standard Cells. Henry S. Carhart (An account of a few standard cells which the writer has kept for several years). Elec Wld—Nov. 14. 1100 w. 15 cts.

9312. A Carbon Cell Without a Metal Electrode. C. J. Reed (Objections made to Dr. D. Tommasi's theory of chemical reactions). Elec Wld—Nov. 21. 500 w. 15 cts.

9366. On the Resistance of the Electric Arc. Julius Frith and Charles Rodgers (Communicated to the Phil. Mag. of the Physical Society. Resistance of the arc is defined, and account given of a series of experiments undertaken to determine the resistance of the arc under various conditions). Elect'n—Nov. 13—5000 w. 30 cts.

9391. Electric Sad Irons in a Hospital for the Insane (Illustrated description of the equipment of the Central Indiana Hospital for the Insane, at Indianapolis, Ind.) Elec Rev—Nov. 25. 800 w. 15 cts.

9393. Insulation. W. M. Stine. (The properties of insulating materials; mechanical difficulties; the care necessary in the application and use of insulation). Elec Eng—Nov. 25. 1200 w. 15 cts.

9462. Some Recent Developments in Magnetic Testing. Prof. Ewing. (Describes a special procedure in the ballistic test of bars. The object is to eliminate the error due to the magnetic resistence of the yoke in tests made with bars and yokes. Elect'n—Nov. 20. 1400 w. 30 cts.

9463. The Direct Production of Electrical Energy. Bertram Blount. (Reviews a recent record of experiment by Herr Ernst Andreas in the Zeitschrift fur Elektrocheme, who has been revising and extending the work of Dr. Borchers). Elect'n—Nov. 20. 1300 w. 30 cts.

9464. Roentgen Ray Apparatus (The latest tubes employed for producing esographs are described and other apparatus used in the work). Elec Rev, London—Nov. 20. 2300 w. 30 cts.

9465. Idle Currents. (A study of the problem of worthless currents and means of suppressing them). Elec Rev, London—Nov. 20. 1300 w. 30 cts.

9494. Roentgen Phenomena—Theory and Practice. Elmer G. Willyoung (An examination of the characteristics of the X-rays and what can be done with them). Pro Engs' Club of Phila—Nov. 5500 w. 45 cts.

9515. Tesla on the Roentgen Streams (Illustrations and conclusions from recent study of this subject. Points out possibilities of producing nitrogen compounds, explains causes of effects on the skin, and shows the hopelessness of making the blind see by the use of X-rays). Elec Rev—Dec. 2. 4000 w. 15 cts.

9537. On the Effect of Removing the Ends of a Magnet. Joseph F. Smith (Experiments made to ascertain the effect of cutting from the ends of a wide, thin magnet strips whose width is small compared with their length). W Elec—Dec. 5. 600 w. 15 cts.

9561. On the Mode of Transferring Energy in the Electric Circuit. Edwin J. Houston and A. E. Kenelly (A suggestion of how the transfer may take place, not merely under the general formula of "motion of Faraday tubes of force through space" but concretely by the use of the more fundamental conception of the energy resident in electrostatic flux). Elec Wld—Dec. 5. 1500 w. 15 cts.

9562. Corrosion Caused by Railway Return Currents. Dugald C. Jackson (Detailed results of experiments to determine the differences in the reactions which occur when lead and iron are respectively the metal of the anode upon which the corrosion takes place). Elec Wld—Dec. 5. 800 w. 15 cts.

9564. Some New Electrical Apparatus. Reginald A. Fessenden (Part first describes a new tachometer and a new alternating-current curve tracer, giving illustrations). Elec Wld—Dec. 5. Serial. 1st part, 3300 w. 15 cts.

9647. Interchangeable Electric Signs. Theodore Waters (Illustrated description of electrical effects for advertising purposes, and the newest features in this business). Elec Eng—Dec. 9. 1600 w. 15 cts.

INDUSTRIAL SOCIOLOGY.

COMMERCE AND TRADE.

9153. The cost of Iron as Related to Industrial Enterprises. George H. Hull (Urging the advantages of exchange dealings in pig iron by the warrant system"). Eng Mag—Dec. 2600 w. 30 cts.

9348. Foreign Shipping Subsidies (The effect of subsidies on English commerce). Engng—Nov. 13. 1200 w. 30 cts.

9386. The Tinplate Industry and American Competition (The impossibility of restoring the scale of 1874, because of the changed conditions, and a report of the progress of the industry in America). Ir & Coal Trds Rev—Nov. 13. 1500 w. 30 cts.

9399. Japan; Its Openings and Opportunities (The importance of this trade to Great Britain; the trade of other countries with Japan; industrial progress in that country). Mach, Lond—Nov. 15. 2500 w. 30 cts.

9401. Tariff Changes and Customs Regulations (Russia, Russian Turkestan, Sweden, Germany, France, France-Dahomey, Spain, Phillipine Islands, Italy, United States, Mexico, Nicaragua, Guatemala, Ecuador, Brazil, Argentina, Liberia, British India, British Honduras, New South Wales and Victoria). Bd of Tr Jour—Nov. 7000 w. 30 cts.

9467. India; Its Arts, Manufactures and Commerce (Address of Sir Owen Tudor Burne, before the Soc. of Arts. Reviews the natural features of the country in order to show the difficulties experienced by those who have had to deal with the arts, manufactures and commerce of the country; notes its natural products; the effect of the arts on the people and gives much interesting information). Jour Soc of Arts—Nov. 20. 6000 w. 30 cts.

9498. Our Trade with South America. Theodore C. Search (Discusses the movement of the United States to secure a large share of the trade of the outer world, especially in South America; considers the conditions and possibilities of this trade, and indicates the general lines for the extension of export trade). N Am Rev—Dec. 2800 w. 45 cts.

9526. Hides and Leather in Europe (Responses from American Consuls in various countries to a circular letter sent by the Dept. of State desiring them to obtain information regarding this industry and how to increase the same in the consular district). Cons Repts—Nov., 1896. 23500 w. 45 cts.

9570. Modern Japan—Industrial and Scientific (A discussion of Anglo-Japanese business relations is given in part first. Also an abstract of the treaty of commerce and navigation between Japan and Great Britain). Eng., Lond—Nov. 27. 3500 w. 30 cts.

9639. The India Rubber Industry in Europe (Statistics relating to the quantity and value of crude India-rubber imported by Russia and the export of manufactures. Also information concerning the trade conditions of this product in Germany). Ind Rub Wld—Dec. 10. 900 w. 35 cts.

9640. The Demand for Rubber Goods in the Amazon. M. F. Sesselberg (Suggestions for increasing trade with some comment on the quality of goods best suited to the people, and on other articles of import). Ind Rub Wld—Dec. 10. 1200 w. 35 cts.

9641. An English View of German Trade Rivalry (Discusses the causes of the falling of England's commerce and industry. Statements from book by Ernest Edwin Williams and from Consular Repts. Remedies suggested). Cons Repts—Dec. 2000 w. 45 cts.

CURRENCY AND FINANCE.

9156. Examination of Corporation Accounts by Auditors. Thomas L Greene

(Showing the functional incapacity of the auditor, as such, to pass upon a corporation's solvency). Eng Mag—Dec. 3300 w. 30 cts.

9642. The Future of Gold. Alex. Del Mar (Discusses free coinage in relation to mining and metallurgy. The eras of gold production are defined and seigniorage is recommended). Gunton's Mag—Dec. 2200 w. 30 cts.

GOVERNMENTAL CONTROL.

9173. Methods of Determining the Economic Productivity of Municipal Enterprises. Walter F. Willcox (Read before the Am. Social Science Assn. The discussion of the subject is limited to the class of enterprises which aim at rendering an economic service). Am Jour of Soc—Nov. 4500 w. 45 cts.

9205. Honesty in the Management of Corporations (Editorial showing the necessity of corporations, comparison of public and private corporations, the temptations to make gains and the protection given by publicity in contracts). Eng. News—Nov. 12. 1800 w. 15 cts.

LABOR.

9150. Labor Riots and So-Called "Government by Injunction." Leonard E. Curtis (Showing that the courts did not exceed their prerogative, or over-estimate the exigency of the occasion, in using their power of injunction to suppress the Chicago riots of 1894). Eng Mag—Dec. 6800 w. 30 cts.

9171. The Working Boy. Florence Kelley (A discussion of the needs to be kept in view in technical education, because of the industrial instability of the times. Changes brought about by recent inventions are discussed). Am Jour of Soc—Nov. 4500 w. 45 cts.

9233. Arbitration in Labor Disputes. Mr. and Mrs. Sidney Webb (The essential features and characteristics of arbitration, the disadvantages from the views of employers and employed, the work of conciliation and the conclusions to be drawn from analysis of the subject). Nineteenth Cent—Nov. 6500 w. 45 cts.

9474. The Strikes and Lock-Outs of 1895 (Extracts from report of Mr. Burnett of the Labor Dept. of the Bd. of Trade. Shows a material diminution as compared with previous years). Col Guard—Nov. 20. 1500 w. 30 cts.

9510. The Leadville Strike (An article endeavoring to set forth the true causes of the trouble). Min Ind & Rev—Nov. 26. 1300 w. 15 cts.

9645. Labor Insurance in Germany (Shows the changed conditions which make provision for maintenance of the wage-earner during disability and old age necessary, and recommends a comprehensive plan of labor insurance). Gunton's Mag—Dec. 1500 w. 30 cts.

MISCELLANY.

9172. Immigration and Crime. Hastings H. Hart. (The writer objects to an article by Mr. F. W. Hewes, in the Outlook of March 7, 1896, claiming that the conclusions are misleading. He gives a different method of comparison and the results, which he claims can be established.) Am Jour of Soc—Nov. 2000 w. 45 cts.

9232. Commercial Morality in Japan. Robert Young. (A discussion of facts which illustrate the standard of commercial morality, and show the effect upon trade.) Nineteenth Cent—Nov. 3800 w. 45 cts.

9421. A Method of Determining Selling Price. H. M. Lane. (A method is proposed by which the conditions affecting the final result of a year's business may be shown in a simple manner at the end of each month or week.) Am Soc of Mech Engs—Dec. 1700 w. 45 cts.

9441. The Industrial Revolution in Japan (From the report of Mr. W. E. Curtis, as published in the Dept. of Labor of the United States. Showing that Japan is becoming less and less dependent upon foreign nations; recent industrial developments, and facts affecting the industries.) Ind & East Eng—Oct. 24. 2200 w. 45 cts.

9456. An Unfeigned Issue. George Bryan. (The writer proposes to give in popular language a synopsis of four judicial decisions affecting the industries of the country, with a few general deductions.) Am Mag of Civ. Nov. 5800 w. 30 cts.

9457. The Fundamental Reform. W. H. T. Wakefield. (The writer claims the criminals, tramps, paupers, &c., are the result of an economic policy which encourages monopolies and discourages industry. The fundamental reform as stated by him is access to nature's bounties upon equal terms for all.) Am Mag of Civ—Nov. 1000 w. 30 cts.

9496. Penal Colonies, Agricultural and Industrial. Arthur Griffiths (Discusses the various penal systems already tried and shows their weaknesses, pronounces the penal colony the best solution of the problem and describes the lines on which it should be planned and governed). N. Am Rev. Dec. 4400 w. 45 cts.

9548. The Modern Version of the Law of Supply and Demand. R. H. Thurston (A discussion of the relations between wages, prices, costs and quantity). Science —Dec. 4. 800 w. 15 cts.

9643. Common Sense in Trusts (Evidences of a true economic view gradually

coming to be recognized. A discussion favorable to trusts). Gunton's Mag—Dec. 1800 w. 30 cts.

9644. Statistics of Immigration (Tables giving results of investigation, with representative facts and their social significance). Gunton's Mag—Dec. 1000 w. 30 cts.

MARINE ENGINEERING.

BOILERS AND ENGINES.

9237. Marine Boilers, Particularly in Reference to Efficiency of Combustion and Higher Steam Pressures. J. R. Fothergill (Read before the Northeast Coast Inst. of Engineers and Shipbuilders, in Cardiff. A discussion of the needs and difficulties, and the demand for increased pressure, with the objections, and general discussion of the subject). Jour Am Soc of Naval Engs—Nov. 3800 w. $1.25.

9340. Testing Steel for Marine Engine Construction. From Inst. of Civ. Engs., Foreign Abstract. (An account of the tests made at the French Government Engine Works, at Indret.) Eng—Nov. 21. 1200 w. 15 cts.

9586. Twisting Moments of Quadruple Expansion Engines. H. J. Teiper (Results and method of obtaining the twisting moments or crank effort as worked out by the writer, with necessary explanations). Eng—Dec. 5. 1500 w. 15 cts.

NAVAL AFFAIRS.

9236. Contract Trial of U. S. Armored Cruiser Brooklyn. W. C. Herbert (Illustrated detailed description of the vessel, with data of trial). Jour Am Soc of Naval Engs—Nov. 6500 w. $1.25.

9307. The Coast Defense Monitor Amphitrite (Illustrated description). Sci Am—Nov. 21. 1300 w. 15 cts.

9330. The New Battleship. Philip Hichborn (Abstract of a paper read before the Soc. of Naval Archts. and Marine Engs. Description of the special features of the Alabama class, the most recently designed battleships of the U. S. Navy, with a tabular statement of the general particulars of the designs). R R Gaz—Nov. 20. 1600 w. 15 cts.

9341. Triple Screw Vessels (Opinion of Prof. Carl Busley, German Navy, in his paper on "Our Fleet," Zeitschrift des Vereines Deutscher Ingenieure). Eng.—Nov. 21. 1000 w. 15 cts.

9350. The Navies of the World (A summary of the fleets of Great Britain, France and Russia, with comments). Eng, Lond—Nov. 13. 2000 w. 30 cts.

9416. Naval Practice in Ship Rivets and Riveting. J. H. Linnard (Read at meeting of the Soc. of Naval Archts. and Marine Engs. Rules for riveting are given in tabular form, the great importance of the subject shown, and general information given). Eng News—Nov. 26. 2400 w. 15 cts.

9495. The Engineer in Naval Warfare. John G. Walker, A. T. Mahan, R. D. Evans and S. A. Staunton (A symposium of opinions on the standing of engineers in the navy). N Am Rev—Dec. 9500 w. 45 cts.

MISCELLANY.

9189. Ship and Stokehold Ventilation (Illustrated description of apparatus patented by Messrs. Evans, Harris & Evans, of Manchester. It is called the "Anemogene" system, and is deserving of the attention of ship owners). Steamship—Nov. 500 w. 30 cts.

9190. Remarks on Sail and Steam Power Combined. H. C. Vogt (A paper designed to show that a special construction of sails is necessary to work efficiently along with steam power, and that sails and steam power, properly constructed, act to the best advantage when used together). Steamship—Nov. 1500 w. 30 cts.

9272. Twin-Screw Steamer Pennsylvania (An illustrated description of the largest steamer afloat). Am Shipbuilder—Nov. 12. 1100 w. 15 cts.

9283. The Atlantic Greyhound of the Future. J. H. Biles, in Cassell's Family Magazine (A review of the increase in speed and a prophecy for the future). Safety V—Nov. 900 w. 15 cts.

9300. Ship Building on the Clyde. Francis S. North (A brief review of the changes brought about in this region, with description of the plant of the Fairfield Company). Yale Sci M—Nov. 1900 w. 30 cts.

9325. Steel Canal Boats. Lewis Nixon (Condensed from a paper read before the Soc of Naval Archts and Marine Eng. Describes the boats and gives midship cross-section drawings. The paper is devoted largely to an argument on the economy of running boats through from lake ports to New York). Eng News. Nov. 19. 2000 w. 15 cts.

9326. Speed Trials of a Screw Propelled Ferry Boat. F. L. Du Bosque (Trials made with the screw-propelled ferry boat Cincinnati are described). Eng News—Nov. 19. 1700 w.

9343. Commissioner of Navigation

Chamberlain's Last Annual Report (Editorial review of the report, with criticisms). Sea—Nov. 19. 6500 w. 15 cts.

9448. About the "Ernest Bazin" (The question of the roller ship is discussed, and illustration given. The theory as presented shows the remarkable result produced by rotation, and the question is considered mainly in relation to speed). Trans—Nov. 20. 1400 w. 30 cts.

9486. The Stability of Ships (Abstract of address by Mr. James Reid at the meeting of the graduates' section of the Scottish Inst. of Engs. and Shipbuilders. Defines and discusses the subject and considers that safer vessels were never built than those of the present. Related matters of interest are briefly considered). Eng. Lond—Nov. 20. 2400 w. 30 cts.

9567. Marine Engineers' Qualifications (Brief extracts from letters from practical men of various classes on the subject of marine engineers' training) Engng—Nov. 27. 1600 w. 30 cts.

9583. Steamship Passages (Comments on the passages of the present year and reviews the progress since the beginning of Victoria's reign). Ill Car & Build—Nov. 27. 2000 w. 30 cts.

9584. Ocean Sailings (Reviews the record since 1838). Ill Car & Build—Nov 27. 1000 w. 30 cts.

9585. Shipbuilding (A discussion, at some length, of the timber supply for shipbuilding, by Mr. G. C. Mackrow. Illustrated). Ill Car & Build—Nov. 27 4200 w. 30 cts.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

9160. Practical Theory of Steam-Making from Shovel to Stop-Valve. Winthrop Thayer (Abstract of a paper read before the N. E. Cotton Mfrs. meeting. Directions for securing perfect combustion and intense heat. Advocating forced draught). Lord's Mag—Nov. 2300 w. 15 cts.

9275. Boiler Incrustation and Its Removal. (Report of the Bavarian Society for Boiler Inspection). Am Mfr & Ir Wld —Nov 13. 1800 w. 15 cts.

9285. Burning Cheap Fuel. W. H. Wakeman, in the "Woodworker" (A discussion of the use of cheap fuel for steam-making purposes, the conditions that favor it and the causes of failure). Safety V—Nov. 2500 w. 15 cts.

9557. Water Hammer. (Some experiments to show when it may occur). Bos Jour of Com—Nov. 21. 1200 w. 15 cts.

9422. Efficiency of the Boiler Grate. William Wallace Christie (Data collected from 108 boiler tests, paying particular attention to the pounds of coal burned per square foot of grate). Am Soc of Mech Engs—Dec. 1200 w. 45 cts.

9432. Ancient Pompeiian Boilers (Ill.) W. T. Bonne. (Proof that the water-tube principle was understood and appreciated by the Greeks and Romans two thousand years ago). Am Soc of Mech Engs—Dec. 2200 w. 45 cts.

9479. Steel for Boilers and Fire Boxes. T. L. Condron (The material for this paper has been collected from the motive power departments of several railroads a few of the locomotive works and steel manufacturers. Specifications of the Am. Ry. Mas. Mech's. Ass'n. for boiler and fire-box steel are also given. Jour W Soc of Engs—Oct. 2800 w. 45 cts.

9481. Explosion of a Kier at a Paper Mill, Bolton. (Report of an investigation with regard to the bursting of a revolving rag boiler or kier, which occurred at the Springfield Paper Works, Bolton.) Eng'ng —Nov. 20. 5000 w. 30 cts.

9504. Starting and Closing Boiler Tests (A discussion as to whether the test should be started with clean grates, with Prof. Carpenter's opinion.) Bos Jour of Com—Nov. 28. 1200 w. 15 cts.

9505. Boiler Making. Henry J. Hartley (Old and new methods contrasted). Bos Jour of Com—Nov. 28. 2200 w. 15 cts.

9547. A New High Temperature Furnace. H. L. Gantt (A study of the actions carried on in the electrical furnaces and other high temperature furnaces Followed by discussion). Jour Fr Inst—Dec. 3500 w. 45 cts.

9549. The Factory Chimney. Robert Kupstman (The functions and construction of a serviceable factory chimney are considered). Brick—Dec. 3300 w. 15 cts

COMPRESSED AIR.

9518. The Best Air Compressor for

Shop Service. Frank Richards (A criticism of some ideas advanced in the discussion on compressed air, at the monthly meeting of the R. R. Club, with the writer's personal opinions). Am Mach—Dec. 3. 1500 w. 15 cts.

9535. Compressed Air Motors. Carl Snyder (Illustrated description of different uses of compressed air, with details of development). Harper's Weekly—Dec. 5. 15 cts.

9551. The Cost and Profit of Compressed Air (Quotations from papers of G. A. True and C. W. Shields, read before the Western Foundrymen's Assn., which are strong arguments for the use of compressed air). Ry Mas Mech—Dec. 2500 w. 15 cts.

ENGINES AND MOTORS.

9155. The Economy of the Modern Engine-Room. E. J. Armstrong (Showing the significance and value of duty tests for engines and boilers). Eng Mag—Dec. 2800 w. 30 cts.

9202. Some Modern Modifications and Accessories of the Steam Engine. J. Warren (A detailed description of a Willans triple expansion engine, and the Parsons steam turbine). Elec, Lond—Oct. 23. 1800 w. 30 cts.

9234. On Crank Shafts. John H. Macalpine. (The investigation deals with the estimation of the various stresses which are induced in the crank shaft of an engine when running. The principal practical result is the ascertaining of the dimensions of a set of crank shafts which, under working conditions, will not in any part have stresses rising above a definite value). Jour Am Soc of Naval Engs—Nov. Serial. 1st part. 16000 w. $1.25.

9238. About Engine Governors (Calls attention to some of the causes which impede their action or hinder them from working). Bos Jour of Com—Nov. 14. 1000 w. 15 cts.

9303. The Balancing of Beam Engines (Answer to an inquiry regarding the method of calculating the balance weight of beam engines. Shows how the work is done). Am Mach—Nov. 19. 1500 w. 15 cts.

9353. Breakdowns of Stationary Steam Engines. Michael Longridge (Read before the British Inst. of Mech. Engs. A short digest of the author's experience. Statistics derived from the last thousand breakdowns with which the writer had to deal previous to Dec. 31, 1894, are given, with statements of facts and explanations). Col Guard—Nov. 13. Serial. 1st part. 4700 w. 30 cts.

9372. Horseless Road Locomotion. A. R. Sennett (Read before the British Assn. Illustrated description of vehicles and what has been done in this field). Ind & Ir—Nov. 13. 10500 w. 30 cts.

9373. Motor Cars and the Advantages of High-Speed Oil Engines. William Norris (The author illustrates, with the Pennington oil motor, how the force of inertia of the moving parts acts as a regulator and modifier of shock in the transmission of the explosive force to the crank). Ind & Ir—Nov. 13. 1400 w. 30 cts.

9374. Old-Time Motor Cars (Illustrated description). Ind & Ir—Nov 13. 1700 w. 30 cts.

9375. Present Time Motor Cars (Illustrated description of various makes). Ind & Ir—Nov. 13. 4000 w. 30 cts.

9376. Self-Propelling Vehicles. A. R. Sennett (Interesting review of prophecies and progress). Ind & Ir—Nov. 13. 8000 w. 30 cts.

9425.—Steam Engine Governors. Frank H. Ball (An investigation of the governing forces and their relations to each other, with conclusions reached. Illustrated). Am Soc of Mech Engs—Dec. 4000 w. 45 cts.

9508. Locomotive Repairing Work. A. H. Newsam Smith (Read before the Inst. of Junior Engs. The writer confines himself to two classes of English engines largely used now, giving description of the main features of the work). Prac Eng—Nov. 20. Serial, 1st part. 4000 w. 30 cts.

9546. The Standard of Efficiency for Steam Engines and Other Heat Motors. R. H. Thurston (The essentials of a satisfactory standard are stated, and standards discussed and studied in some detail in part 1st). Jour Fr Inst.—Dec. Serial. 1st part. 4000 w. 45 cts.

9578. Recent Developments in Mechanical Road Carriages. W. Worby Beaumont (A full paper, reviewing the causes that have retarded the progress of invention, the different races and trials of motor carriages, the construction of the vehicles, with illustrations, and subjects related). Jour Soc of Arts—Nov. 27. 11500 w. 30 cts.

POWER AND TRANSMISSION.

9174. Hydraulic Power Transmission. Gustave Kaufman (From a paper read before the Engs.' Soc. of W. Penn. Describes briefly a system of power transmission which is largely in use in England. It is the distribution of water at very high pressures, from 700 to 2000 pounds per square inch). Ir Age—Nov. 12. 3000 w. 15 cts.

9364. On Cheap Steam Power. J. S. Raworth (Read before the Northern Soc. of Elec. Engs. A discussion as to whether the cost of steam power can be reduced). Elec Eng, Lond—Nov. 13. 3800 w. 30 cts.

9413. The New Power Plant of the

Washington Mills Co., Lawrence, Mass. (Illustrated description of the power plant of what is claimed to be the largest woolen mills in the world). Eng News—Nov. 26. 2000 w. 15 cts.

9418. Friction Horse-Power in Factories. C. H. Benjamin (Tabular data, with explanations, secured in a series of experiments made to determine the ratio of the power required to drive shafting and belts in various factories to the total power consumed). Am Soc of Mech Engs—Dec. 1500 w. 45 cts.

9506. Ropes and Rope Driving. G. H. Kenyon (Part first reviews briefly the history and deals with positive motion, wedging action and construction of grooves). Mech Wld—Nov. 20. Serial, 1st part. 1800 w. 30 cts.

SHOP AND FOUNDRY.

9151. Six Examples of Succesful Shop Management, III. Ill. Henry Roland (Showing the methods of the Yale & Towne Co. in dealing with their employees). Eng Mag—Dec. 5300 w. 30 cts.

9180. Cost Keeping—Some Large Air Hoists—A Right-Angle Coupling—A Rack Cutter—The Centers of Arbors. S. T. Freeland (Brief consideration of subjects named). Am Mach—Nov. 12. 2600 w. 15 cts.

9181. Pump Balancing. W. H. Booth (The subject is discussed and an illustrated description of arrangement of pump given). Am Mach—Nov. 12. 1800 w. 15 cts.

9291. Screws and Screw-Making. L. A. Murray (The history of screw-making is briefly given, its requirements stated, with description of the method of manufacture). Sib Jour of Engng—Nov. 3000 w. 30 cts.

9304. Bicycle Brazing. Hugh Dolnar (Illustrated description, with historical review of the art). Am Mach—Nov. 19. 2400 w. 15 cts.

9406. Some Forms of Screw-Swaging Machines (Illustrated description of the machines and of their operation). Ir Age—Nov. 26. 900 w. 15 cts.

9409. Press and Die Work on Bicycles (An illustrated outline of the general principles). Am Mach—Nov. 26. 2300 w. 15 cts.

9410. Some Features of a Modern Shop—Casting Storage, Stock Room, Points About Scraping. S. T. Freeland (Illustrated description of some features in a Cincinnati shop). Am Mach—Nov. 26. 2000 w. 15 cts.

9411. "Limit" Taps. Horace L. Arnold. (Illustrated description of taps of this form, which the writer claims will produce tapped holes varying in diameter only within fixed limits). Am Mach—Nov. 26. 2500 w. 15 cts.

9429. Contraction and Deformation of Iron Castings in Cooling from the Fluid to the Solid State. Francis Schumann. (The results of twelve years of observation and research by the writer, with conclusions. Am Soc of Mech Engs—Dec. 3800 w. 45 cts.

9431. Experimental Investigation of the Cutting of Bevel Gears with Rotary Cutters. Forrest R. Jones and Arthur L. Goddard. (Abstract of a thesis presented by Mr. Goddard for the degree of B. S. in mechanical engineering. Describes apparatus constructed and used experimentally in order to obtain the proper setting for gears of different centre angles). Am Soc of Mech Engs—Dec. 2500 w. 45 cts.

9444. Improvement of Cupola Practice. James A. Beckett. (A response to the circular letter asking for suggestions for improvement in cupola practice in the foundry. The writer thinks the greatest need is a more general knowledge of cause and effect in the matter of combustion of fuel in the cupola; in fact, more intelligence in the workers). Ir Tr Rev—Nov. 26. 1800 w. 15 cts.

9459. Some Pencil Sketches of Failures. H. Hansen. (A study of bad castings and their causes). Foundry—Nov. 1400 w. 15 cts.

9460. The Influence of Heat Upon Cast Iron. S. S. Knight. (Observations upon the foundry methods in use, with suggestions set forth, which the writer claims to be an improvement). Foundry—Nov. 1600 w. 15 cts.

9507. The Manufacture of Iron and Steel Tubes. Edward C. R. Marks. (The subject will be confined to butt and lap welded tubes of iron, open or close jointed and consolidated tubes, and processes for the production of weldless or seamless steel tubing for the construction of bicycle frames and for other purposes). Prac Eng—Nov. 20. Serial. 1st part 2000 w. 30 cts.

9516. "Planed" Bevel Gear Teeth. George B. Grant. (The definition of "planed" as applied to gear teeth is given, and the four methods now in use for cutting the teeth of bevel gears are explained). Am Mach—Dec. 3. 5500 w. 15 cts.

9517. The Construction of an Accurate Large Spur Gear (An outline of the methods employed in the construction of a difficult piece of work). Am Mach—Dec. 3. 1200w. 15 cts.

9521. Making Armature Disks (Outline of the various methods, with illustrations of several modern machines adapted to this work). Am Mach—Dec. 3. 1400 w. 15 cts.

9591. Improvement in the Foundry. W. J. Keep (Calls attention especially to the loss occasioned by bad castings). Mach—Dec. 1200 w. 15 cts.

9633. The Stripping of Bushes (Customary practice, with suggestions for special cases). Prac Eng—Nov. 27. 900 w. 30 cts.

MISCELLANY.

9182. Atoms and Molecules. (Abstract from article in N. Y. Sun, by Robert S. Ball. Facts which should be understood by mechanics.) Am Mach—Nov. 12. 1800 w. 15 cts.

9199. Superheating. Michael Longridge. (Explains how superheated steam differs from saturated steam, its action and the benefits to be derived.) Eng's Gaz—Nov. 2500 w. 30 cts.

9212. The Value of the Steam Jacket on a Locomotive Engine. Prof. T. Hudson Beare and Mr. Bryan Donkin. (Report of the Research Committee of the Inst. of Mech. Engs. Description of the experiment and the general results.) Eng, Lond—Nov. 6. 2200 w. 30 cts.

9227. Superheated Steam. W. E. Burgess. (The writer proposes in the following articles to show in what way the use of superheated steam increases the economy in the engine, to give the best methods of investigating and comparing the performance of engines using both saturated and superheated steam, by means of heat charts; to examine the actual efficiencies of engines using superheated steam and discuss the influence of the superheater on the general economy of a power station.) Elec Engng—Nov. Serial. 1st part. 3000 w. 15 cts.

9228. Some Notes on Fly Wheels. Irving A. Taylor. (Examines some points which the writer thinks were not carefully considered in Mr. Williams's article in the August number of Elec Engng.) Elec Engng—Nov. 1200 w. 15 cts.

9229. Methods of Fuel Testing. Arthur V. Abbott and Franz J. Dommerque. (Describes the methods in vogue for the determination of calorific power, and shows the importance of the work in relation to power production.) Elec Engng—Nov. 3400 w. 15 cts.

9235. Tests of Riveted Joints Made at the Watertown Arsenal, Mass., for Messrs. Edward Kendall & Sons, Cambridgeport, Mass., May 29, 1896. (Description and results of tests, supplied by the designers and makers of the joints). Jour Am Soc of Naval Engs—Nov. 2200 w. $1.25.

9239. The Engineer of To-Day (His responsibility and what he is required to know). Bos Jour of Com—Nov. 14. 2800 w. 15 cts.

9241. The Recent French Motor Car Competition (An account of the arrangements, the preliminary test and the long race. In this trial the importance of pneumatic tires was shown, and also the fact is noted that petroleum entirely superseded steam). Engng—Nov. 6. 3300 w. 30 cts.

9308. The First Bicycle. From "La Nature" (Illustrated description of machines of 1819, with historic data from book of M. Baudry de Saunier). Sci Am Sup—Nov. 21. 600 w. 15 cts.

9321. The application of Suction Pipes to the Handling of Grain at Millwall Docks, England (Description, with illustrations of the appliances. Taken from paper of Frederick Eliot Duckham, as published in Trans of Inst. of Civ Engs). Eng News—Nov. 19. 2400 w. 15 cts.

9334. Worcester Polytechnic Institute Hydraulic Laboratory (Illustrated description). Eng Rec—Nov. 21. 1200 w. 15 cts.

9342. Boat Channel Dredgers for the Colonies (The need of type of dredger for special work is shown, and the conditions are stated). Ind & East Eng—Oct. 17. 1000 w. 45 cts.

9347. Expanded Metal (An illustrated description of machine devised by Mr. Golding). Engng—Nov. 13. 800 w. 30 cts.

9377. Methods of Determining the Dryness of Saturated Steam. Osborne Reynolds (Abstract of a paper read before the Manchester Literary and Philosophical Society. A discussion with consideration of conditions necessary for securing accuracy). Prac Eng—Nov. 13. 500 w. 30 cts.

9420. Paper Friction Wheels. W. F. M. Goss (Some applications of the paper friction wheel are presented diagrammatically, with brief description of their action, experiments and a summary of results). Am Soc of Mech Engs—Dec. 1800 w. 45 cts.

9423. A Two Hundred-Foot Gantry Crane. John W. Seaver (Illustrated description of the plant of the Cambria Iron Co., of Johnstown, Pa., installed in their storage and loading yard). Am Soc of Mech Engs—Dec. 2800 w. 45 cts.

9424. Method of Determining the Work Done Daily by a Refrigerating Plant and Its Cost. Francis H. Boyer (Describes a method of obtaining the amount of work accomplished daily, used in the abbattoir of John P. Squire & Co., East Cambridge, Mass). Am Soc of Mech Engs—Dec. 1100 w. 45 cts.

9426. Some Special Forms of Computers. F. A. Halsey (Describes a type of computer for solving mechanical problems. Cox's Strength of Gear Computer). Am Soc of Mech Engs—Dec. 1100 w. 45 cts.

9428. Calibration of a Worthington Water Meter. John A. Laird (Results of a series of meter calibrations. The meter tested was a Worthington, made entirely of brass, for hot water, and purchased for

testing purposes). Am Soc of Mech Engs —Dec. 500 w. 45 cts.

9430. The Moment of Resistance. C. V. Kerr (Two methods, the analytical and the graphical, are offered for determining the resisting moment directly from the cross section of a given beam.) Am Soc of Mech Engs—Dec. 2200 w. 45 cts.

9502. On Certain Physical Difficulties in the Construction of Large Guns. W. Le Conte Stevens (Describes the Treadwell plan for gun construction, which has been universally adopted, and the difficulties met with in shrinking the jacket and adjusting it to the cold tube). Science—Nov. 27. 2800 w. 15 cts.

9519. Formulae for Ball Bearings. H. Rolfe (Some supplementary remarks called forth by Mr. Babbitt's letter on this subject, taking into account the matter of clearance between the balls). Am Mach—Dec. 3. 1000 w. 15 cts.

9520. Diagram of Proportions of Elliptical Arms (Diagram for determining the dimensions of elliptical arms for belt or rope pulleys, or similar wheels used for power transmission. From the reference book of S. E. Freeman, of the Todd & Stanley Mill Furnishing Company, St. Louis, Mo.) Am Mach—Dec. 3. 500 w. 15 cts.

9522. Foundry Costs. (Abstracts of a series of reports made to the New England Foundrymen's Association). Ir Age—Dec. 3. 3500 w. 15 cts.

9540. Abrasion and Etching Tests of Wrought Iron and Steel Car Axles (Report of L. R. Pomeroy of tests made in the laboratory of the Cambria Iron Co., with illustrations). RR Gaz—Dec. 4. 1200 w. 15 cts.

9587. Computing Horse-Power from the Indicator Diagram—Approximate Water Consumption. F. F. Hemenway (Directions for computations, with plan for approximate water consumption used by the Buckeye Engine Co.). Loc Engng —Dec. 1000 w. 30 cts.

9592. A System of Drawing-Room Records (The plan described is the outgrowth of a process of trial covering an extended period). Mach—Dec. 1500 w. 15 cts.

9593. Steam Economics. W. H. Booth (General discussion of the subject). Mach —Dec. 1800 w. 15 cts.

9616. The Commercial Organization of Factories (Review of a book by J. Slater Lewis. It is for the use of manufacturers, directors, engineers, secretaries, accountants, draughtsmen, &c.) Ir & Coal Trds Rev—Nov. 27. 4000 w. 30 cts.

9618. Some Common Fallacies with Regard to Steam and the Steam Engine, and the Lessons They Teach (Calls attention to a few fallacies, some of which are a source of danger to the inexperienced). Ind & Ir—Nov. 27. 1500 w. 30 cts.

9634. Five Years Apprenticeship in an Engine Room. M. W. Danielsen (The work necessary to perfect an engineer is briefly reviewed and information given on several subjects). Age of St—Dec. 5. 1800 w. 15 cts.

MINING AND METALLURGY.

COAL AND COKE.

9195. Washing and Sizing Coal. F. W. Hardwick (A lecture delivered at Mansfield, Eng. Various methods employed in the mechanical separation and removal of impurities. Descriptions of leading types of washing appliances, their construction and the principles of their action in washing and sizing). Col Eng—Nov. 5000 w. 30 cts.

9222. The Baum Coal Washing Apparatus (Illustrated description). Col Guard —Nov. 6. 2500 w. 30 cts.

9359. Conversion of Culm Into Gas. N. W. Perry (Extract from a paper read at meeting of the Anthracite Coal Operators Ass'n. A study of the question leads the writer to the conclusion that the solution of the problem of the utilization of anthracite culm lies in its conversion first into fuel gas, to be burned in gas engines, and transmitting the energy electrically). Am Mfr & Ir Wld—Nov. 20. 3300 w. 15 cts.

9427. The Washing of Bituminous Coal by the Luhrig Process. J. V. Schaefer (A detailed description of the latest plant built on the Luhrig system, with a brief consideration of the nature of the impurities, the means to remove them and the advantages of cleaned coal.) Am Soc of Mech Engs—Dec. 4200 w. 45 cts.

9469. A New Work on the Coal Industry (Review of a work by H. F. Bulman and R. A. S. Redmayne. Many extracts are given and very favorable comment). Ir & Coal Trds Rev—Nov. 20. 4300 w. 30 cts.

9470. Ashington Colliery, Northumberland (Detailed description of the three pits). Col Guard—Nov. 20. 2700 w. 30 cts.

9574. The Heidelberg Coalfield, Transvaal. Thomas B. Shipley (Descriptive account). Col Guard—Nov. 27. 1400 w. 30 cts.

9577. Colliery Working in the Pas-de-

Calais. M. E. Duporeq (From the official report. Economical and technical observations, with description). Col Guard—Nov. 27. 1700 w. 30 cts.

9621. Coal Mining by Machinery (A brief outline of the operation of coal getting is given, with comment on the limited progress yet made in this work. Broadly classifies all coal cutters under three heads and gives particulars relating to their use). Min Jour—Nov. 28. 1700 w. 30 cts.

9625. The Analysis of Coke. George C. Davis (Read before the Foundrymen's Assn. Means for determining its suitability for use in blast furnace or cupola. Describes the proximate analysis of coke). Am Mfr & Ir Wld—Dec. 4. 1200 w. 15 cts.

COPPER.

9217. Improvements in the Electrolytic Refining of Copper. Titus Ulke (Reviews recent improvements). Eng & Min Jour—Nov. 14. 900 w. 15 cts.

9438. Present Method of Treating Slimes from the Copper Refineries. Titus Ulke (The three ways in which slimes are refined when lead works are run in connection with the copper refinery are briefly stated). Eng & Min Jour—Nov. 28. 1700 w. 15 cts.

GOLD AND SILVER.

9185. The Cyanide Process Patents Declared Void in the Transvaal (An account of the use of this process in South Africa, the large amount of gold recovered by it, the heavy royalties, and the successful effort to have the patent set aside in South Africa. It is believed that it will result in a general overthrow which will cause immense additions to the world's stock of gold). Sci Am—Nov 14. 2300 w. 15 cts.

9196. Summit District Gold Regions (An epitome of a description of the ore deposits of Summit District, Rio Grande County, Colorado, by R. C. Hills. Prepared by Prof. Arthur Lakes. Illustrated). Col Eng—Nov. 1800 w. 30 cts.

9214. The Cyanide Patent Decision in the Transvaal (An account of the case and the effect the decision will have in the Transvaal, with some information relating to other countries, and a brief summary of the history of the cyanide patents). Eng & Min Jour—Nov. 14. 1800 w. 15 cts.

9251. The Silver-Lead Mines of New South Wales (Illustrated historical account of the Broken Hill Mine). Aust Min Stand—Sept. 2500 w. 30 cts.

9252. The Gippsland (Vic) Goldfields. Donald Clark (Describes the mining prospect and gives the history of the region. It has proved a good field for miners, but is not a field for the capitalist). Aust Min Stand—Sept. 2800 w. 30 cts.

9254. The Greatest Gold Mine in Australia (History of the Discovery of Mount Morgan as told by Edwin Francis Morgan, with scientific theories on the origin of the deposit. Illustrated). Aust Min Stand—Sept. 4000 w. 30 cts.

9255. The Saving of Gold in Refractory Ore Bodies. Dr. Storer (Illustrated brief description of the two methods now used). Aust Min Stand—Sept. 900 w. 30 cts.

9256. Treatment of Broken Hill Sulphide Ores. F. J. Greenaway (The importance of the treatment and the operations, with their advantages and disadvantages). Aust Min Stand—Sept. 1700 w. 30 cts.

9258. The Ballarat Goldfield. William Bradford (Illustrated description of its main features). Aust Min Stand—Sept. 3800 w. 30 cts.

9264. The Alluvial Gold of Otago, N. Z From the New Zealand Mining Journal (An attempt to explain the presence of so much gold in the rich placers, rivers and creeks). Aust Min Stand—Oct. 8. 2300 w. 30 cts.

9293. Recent Development of Mining in Ontario (Information from the report of Dr. A. P. Coleman to the Bureau of Mines relating to the goldfields of this region). Can Eng—Nov. 2000 w. 15 cts.

9322. The Gold Mines of North Carolina. Maxwell J. Gorman (A review of gold mining in this locality, with descriptions of the mines of greatest promise). Eng News—Nov. 19. 3300 w. 15 cts.

9336. Oceanic Gold. Henry Wurtz (A letter to the editor calling attention to an article in the London Chemical News by Mr. A. Liversidge with discussion of the subject and matters related). Eng & Min Jour—Nov. 21. 1800 w. 15 cts.

9370. Gold Mining in British Guiana (Concludes that with free milling, gold of a high grade of value, such as is reported to prevail in the northwest district of British Guiana, and moderate working expenses, the investor may look for success). Min Jour—Nov. 14. 2400 w. 30 cts.

9390. The Loss of Flour Gold in Australian Mines. J. Cosmo Newberry (Discusses the causes of loss in gold mining and what is done to save gold). Aust Min Stand—Oct. 15. 2200 w. 30 cts.

9452. Some Economic Features in Connection with Mining on the Witwatersrand Gold-Fields, South African Republic. Edgar P. Rathbone (Read before the Inst. of Min. & Met. Deals with the mining of gold-bearing conglomerates on the Witwatersrand, Klerksdorp and Heidelberg goldfields collectively). Min Jour—Nov. 21. 2800 w. 30 cts.

9511. The Smuggler-Union Mines, Telluride, Colo. J. A. Potter (Data relative to this property and the treatment of

its ore. Read at Colorado meeting). Min Ind & Rev—Nov. 26. 2600 w. 15 cts.

9533. The Liquation of Certain Alloys of Gold. F. H. M. (A discussion of valuable facts brought out in a paper by Edward Matthey in "Philosophical Transactions." Experiments are given and conclusions drawn by Mr. Matthey). Can Min Jour—Nov. 1000 w. 30 cts.

9542. The Silver Mines at Joachimstahl, Bohemia. R. Helmhaeker (Historical sketch with account of the present state of mining). Eng & Min Jour—Dec. 5. 3000 w. 15 cts.

9543. The Bald Mountain District, Wyoming. Fred D. Smith (Describes district and examines statements made by Mr. Tewksbury, manager of the Fortunatus Co. His claims that gold is present in the rocks of this region are not supported by the investigations of the writer). Eng & Min Jour—Dec. 5. 1600 w. 15 cts.

9649. The Gold Fields of South Africa. George F. Becker, in the Cosmopolitan (The gold deposits are described and a few statistics given with bright prophecies for the future). W Min Wld—Dec. 5. 2000 w. 15 cts.

IRON AND STEEL.

9292. Progress in Blast Furnace Construction. W. O. Amsler (Improvements in design and construction are reviewed, with description of the furnace as at present constructed, and improvements coming into use). Sib Jour of Engng—Nov. 4000 w. 30 cts.

9306. Iron and Steel in China and Japan. R. V. B. (The condition of the market for these products is discussed, with a review of the history of these industries in the countries named, and the changes brought about in China). Ir Age—Nov. 19. 2000 w. 15 cts.

9358. Fluid Compression of Steel. H. K. Landis (A criticism of statements made by W. F. Durfee and published in the "Journal of the Franklin Inst."). Am. Mfr & Ir Wld—Nov. 20. 1800 w. 15 cts.

9360. The Iron Industry of the Ural Mountains. J. Kowarsky (Describes briefly the ore, mines and methods). Am Mfr & Ir Wld—Nov. 20. 1600 w. 15 cts.

9433. Historical and Technical Sketch of the Origin of the Bessemer Process. Sir Henry Bessemer (A brief account of the early origin of the Bessemer process of steel manufacture as developed at the bronze powder manufactory in London. Illustrated). Am Soc of Mech Engs—Dec. 6000 w. 45 cts.

9436. The By-Products of the Blast Furnace. A. Humboldt Sexton (The importance of the blast furnace in the industries; the vastness of the material which they consume and reproduce in another form; a study of what goes on in the furnace; value and use made of the by-products; with history of the pioneers of the recovery process). Phil Soc of Glasgow. 4500 w. 45 cts.

9468. Recollections of the Anthracite Pig-Iron Industry. E. Roberts (Information on some points, with remarks relative to the costs and yields of actual workings at Guiscedwyn and in America). Ir & Coal Trds Rev—Nov. 20. 2700 w. 30 cts.

9603. New Method for Determining the Amount of Sulphur Contained in Iron (Eine neue Methode zur Bestimmung des Schwefels im Eisen). Wilh. Schulte (Description of new chemical compounds used for this purpose). Stahl und Eisen. Nov. 1, 1896. 4300 w.

9632. American Rolling Mills. Samuel T. Wellman (Read before the Inst. of Civ Engs. Part first traces the development of labor-saving appliances in this industry, and specially describes the work of the Joliet Works of the Illinois Steel Co., with illustration of ingot charging machine). Ir & St Trds Jour—Nov. 28. Serial. 1st part. 2200 w. 30 cts.

MINING.

9159. English Practice in Transmitting Power in Mines (Reviewing Mr. Rankin Kennedy's discussion of steam, compressed air and electricity as motive powers for transmission purposes). Eng Mag—Dec. 3700 w. 30 cts.

9194. The Crown Point Mine and Knickerbocker Tunnel, Idaho Springs, Colo. Arthur Lakes (The situation of the latter and a comparison of the circumstances under which it is driven, with numerous other past and prospective tunnel schemes). Col Eng—Nov. 2000 w. 30 cts.

9216. The Avery Island Salt Mine and the Joseph Jefferson Salt Deposit Louisiana (Illustrated description of the mine, with brief history and account of the system of mining). Eng & Min Jour—Nov 14. 1700 w. 15 cts.

9220. Sinking and Lining a Shaft at a French Colliery Aime Gardon (From a communication to the Societe de l'Industrie Minerale. Description with illustrations). Col Guard—Nov. 6. 4800 w. 30 cts.

9221. Experiments Bearing on the Causes of Explosions. J. Coquillion (Explanation of phenomenon produced by the uniting of oxygen and hydrogen). Col Guard—Nov. 6. 900 w. 30 cts.

9352. Romer's Automatic Apparatus for Insuring Safety in Winding (Describes an apparatus which prevents the rising cage from coming to bank at too great a speed, and, to a certain extent, a too sharp setting down at the landing of the descending cage). Col Guard—Nov. 13. 3000 w. 30 cts.

9354. Shaft Sinking at the Royal Brown Coal Pit near Loderburg, Germany. From Zeitschrift fur Burg-Hutten-und Salinenwesen (Describes the sinking of a shaft under peculiar difficulties, owing to the presence of a layer of fine-grained quicksand). Col Guard—Nov. 13. 1200 w. 30 cts.

9355. Laying Out Pit Bottoms. W. Stewart (The importance of the subject in the laying out of a new colliery is presented, with discussion of main points and a brief description of the laying out of the Vivian Pit, Abertillery). Col Guard—Nov. 13. 3300 w. 30 cts.

9379. The Covering of Up-Cast Pits. George H. Hollingworth (Describes some of the means devised for the covering of up-cast pits, where used for winding purposes, with the object of so closing the top as to prevent loss or leakage of air without materially interfering with the banking operations). Prac Eng—Nov. 13. 1600 w. 30 cts.

9394. Electricity vs. Compressed Air—Actual Results in a Mine of the Colorado Fuel and Iron Co. Lewis Searing, with editorial (An illustrated account of tests favorable to electricity. Elec Eng—Nov. 25. 2400 w. 15 cts.

9437. A Log Dam for a Mining Power Plant. Robert Gilman Brown (Illustrated description of additions made to the power plant of the Standard Consolidated Mining Co., at Bodie, Cal. An important part of the work was the construction of a new dam). Eng & Min Jour—Nov. 28. 1200 w. 15 cts.

9472. Filling Worked Seams with Mining Waste Arnao Colliery (Asturias), Spain. (Describes a method made necessary in working a seam with a thin cover rock under the sea, the circumstances being complicated by the strong tendency of this coal to ignite spontaneously). Col Guard—Nov. 20. 1500 w. 30 cts.

9475. Safety apparatus for Winding Engines. (From a communication by Herr Baumann to the upper Silesian Assn. of German Engs., published by "Gluckauf." Illustrated description). Col Guard—Nov. 20. 1200 w. 30 cts.

9532. Mine Drainage. Hans C. Behr. (Report to California Mining Bureau. Describes water-raising machines used in mining; conditions affecting the working of pumps; starting, priming and draining pumps and desirable features. Also different materials for pipes, with illustrations, pipe connections, flanges, &c.) Can Min Jour—Nov. Serial. 1st part. 3800 w. 30 cts.

9573. Adaptation of an Air Shaft for Winding. M. Prosper Vanhassel. (From a communication to the Societe de l'Industrie Minerale, Saint Etienne. Illustrated description of methods). Col Guard—Nov. 27. 4300 w. 30 cts.

9575. Underground Haulage at Cannock and Rugeley Collieries. Robert S. Williamson. (From a paper read before the South Staffordshire and East Worcestershire Institute of Mining Engs. The systems used are main-and-tail-rope endless rope by power, and endless rope on self-acting inclines, &c. The powers used are steam, compressed air and electricity). Col Guard—Nov. 27. 2500 w. 30 cts.

9576. Chopwell Colliery, Durham. J. R. Gilchrist (From the Journal of the British Society of Mining Students. Describes buildings and plant, boilers, shaft guides, headgear, screening, waterworks, railway and incline). Col Guard—Nov. 27. 2000 w. 30 cts.

MISCELLANY.

9164. The Specific Heats of the Metals. F. A. Waterman. (Considers the purity of the metals used; the determination of temperatures; the methods employed and results obtained, with tabulated determinations). Phys Rev—Nov.-Dec. 5000 w. 45 cts.

9166. The Viscosity of Mercury Vapor. A. A. Noyes and H. M. Goodwin. (Read at the Buffalo meeting of the Am. Assn. for the Adv. of Science and at the meeting of the Am. Acad. of Arts and Sciences. Investigations undertaken to determine whether a marked difference in value exists in the case of gases with monatomic and those with polyatomic molecules). Phys Rev—Nov.-Dec. 2200 w. 45 cts.

9193. General Practice in Surveying Mineral Lands and Gold and Silver Mines. Auguste Mathez (A description of the instruments, their use, adjustment and care, with explanations of the principles involved in practical work. Illustrated). Col Eng—Nov Serial. 1st part. 2300 w. 30 cts.

9215. The Phosphate Deposits in Maury County, Tennessee. J. B. Killebrew (An account of the discovery and character of the rock; the locality covered and the work in progress). Eng & Min Jour—Nov. 14. 1500 w. 15 cts.

9226. The West Australian Mining Industry. C. C. Longridge, with editorial comments (Discusses and objects to statements made by Mr. Van Oss in his article on the Rand Mining Industry, which appeared in the Nineteenth Century. Tabular statement of crushings is given.) Min Jour—Nov. 7. 1400 w. 30 cts.

9231. The Westralian Mining "Boom." S. F. Van Oss (An examination of the methods pursued in creating the 80,000,000 shares of stock, and the means adopted to distribute them among the public). Nineteenth Cent—Nov. 4000 w. 45 cts.

9253. The Mineral Fields of the West Coast of Tasmania (General description of the fields, setting forth the principal facts as to their topography, geological structure, and the local conditions under which mining has to be carried on). Aust Min Stand—Sept. 5000 w. 30 cts.

9259. Geology as Applied to Mining. James Stirling (The importance of a knowledge of geology to the mining engineer, and the facts that are helpful to him). Aust Min Stand—Sept. 3500 w. 30 cts.

9260. The Greatest Tin Mine in the Southern Hemisphere (Description, with illustrations, of the Mount Bischoff Mine, Tasmania). Aust Min Stand—Sept. 3500 w. 30 cts.

9261. A Copper-Silver-Gold Mountain, Tasmania (Description of the mines of the Mount Lyell Company, on the west coast of Tasmania). Aust Min Stand—Sept. 1600 w. 30 cts.

9262. The Origin of Valuable Mineral Deposits. Frederick Danvers Power (A review of the hypotheses advanced, with the arguments for and against them). Aust Min Stand—Sept. Serial, 1st part. 4500 w. 30 cts.

9263. The Bituminous Shales of New South Wales (Deals with the so-called bituminous shale, which contains volatile, hydro-carbon in large quantities, variously known as torbanite, boghead mineral, joadja mineral, petroleum oil, cannel coal, and shale, and is now only procurable in New South Wales. Illustrated). Aust Min Stand—Oct. 1. 2000 w. 30 cts.

9276. The Velna Process for the Manufacture of Briquettes from Waste Coal and Mineral Tar (L'Industrie describes a process devised by the chemist Velna, who uses petroleum or mineral tar only for enriching culm and other inferior combustibles, and produces briquettes from this material, the heating power of which is 30 per cent. higher than that of good coal). Am Mfr & Ir Wld—Nov. 13. 1100 w. 15 cts.

9310. Barre, Vermont, Granite Quarries. From the Burlington, Vt., "Free Press." (Interesting account of the granite industry and the social conditions affecting it). Stone—Nov. 3300 w. 30 cts.

9311. President J. H. Neff's address before the California Miners' Association (Largely devoted to the results accomplished by the organization). Min & Sci Pr—Nov. 14. 4400 w. 15 cts.

9337. A Sketch of Mine La Motte, Missouri. Charles R. Keyes (Describes one of the most famous lead mines of the country). Eng & Min Jour—Nov. 21. 2000 w. 15 cts.

9338. The Long-Wall Coal-Mining Region of Grundy County, Illinois (Illustrated description). Eng & Min Jour—Nov. 21. 1500 w. 15 cts.

9344. Possibilities of Cupola Practice (A letter from Dr. Edward Kirk on the use of hot-blast, and a letter from Herbert M. Ramp showing the real need in cupola practise to be brains). Ir Tr Rev—Nov. 19. 1300 w. 15 cts.

9371. The Mineral Resources of New Mexico. Thomas Tonge (A brief notice of the leading mineral-producing counties with related information). Min Jour—Nov. 14. 3000 w. 30 cts.

9385. Factors in Ore Deposition in Arizona. A. F. Wuensch (Discusses the peculiarities of the region under consideration). Min Ind & Rev—Nov. 19. 1200 w. 15 cts.

9442. The Relation of Geology to the Development of the Mineral Resources of the State. Harold W. Fairbanks (Read before the California Miners' Convention. Shows the benefits arising from the systematic investigations of geological surveys, and gives an idea of what a survey might accomplish). Min & Sci Pr—Nov. 21. 4300 w. 15 cts.

9471. Royal Mines (Explains what mines are termed royal and why). Col Guard. Nov. 20. 1000 w. 30 cts.

9473. Estimation of Sulphur in Metallurgical Products. L. Compredon (From Revue Universelle des Mines. A monograph. The result of the investigation and study of many years. The first part contains an introduction and examines the question of the selection of specimens). Col Guard. Nov. 20. Serial. 1st part. 2100 w. 30 cts.

9544. The extraction of Sulphur from Brimstone Ore. Edward F. White (The methods in use for the mechanical separation are stated, and White's apparatus for the extraction of sulphur from ore is described). Eng & Min Jour—Dec. 5. 1000 w. 15 cts.

9617. A Few Points for Prospectors. Dan De Quille (Directions for guidance in exploring new regions). Min & Sci Pr—Nov. 28. 2200 w. 15 cts.

9620. Mining in Victoria (Discusses the rapid departure of the male population and the causes, and offers suggestions to check the exodus). Min Jour—Nov. 28. 2000 w. 30 cts.

9264. Action of Water of the Hubb Coal Mine Upon Cast Iron. Frank W. Durkee (It was found that the cast iron, used for the purposes of construction within the mine, had undergone such radical changes that, while retaining their original size and shape, they could easily be broken and were no longer strong and fairly tough like cast iron. Investigations are given). Am Chem Jour—Dec. 2400 w. 45 cts.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

9198. Commercial Testing of Gas Coal. T. Glover (Read before the Midland Assn. of Gas Managers, Eng. Advises the frequent testing of well-known coals and accurate tests of all suitable coals offered, and gives suggestions for test plant, its working and comparison of results. Discussion follows). Jour of Gas Lgts—Nov. 3. 3800 w. 30 cts.

9289. Natural Gas. J. M. Buckley (The gradual decrease of output at all points, showing that the early predictions as to the permanency of the supply were at fault, but predicting that the use of gas as a fuel will continue and a cheaper and better gas will take the place of the natural product). Pro Age—Nov 16. 1500 w. 15 cts.

9290. Comparative Test of the Calorific Powers of Wilkinson Carburetted Water Gas and Lowe Carburetted Water Gas with the Junker Calorimeter. Martin Shepard, Rudolph E. Bruckner and John Schimmel, Jr. (Graduating thesis of students of Stevens Inst. Methods of analysis are given and the plan of tests made, with results). Pro Age—Nov. 16. Serial. 1st part. 2800 w. 15 cts.

9305. A New Loomis Fuel Gas Plant (Illustrated description of the plant of the Citizens' Gas Company of Bridgeport, Conn.; the largest fuel gas plant for general service in the world). Ir Age—Nov. 19. 1200 w. 15 cts.

9368. The Residuals Market. W. E. Price (Read before the Southern District Association of Gas Engineers and Managers. A few particulars and statistics of the condition, past and present, of the market in residuals of gas works, followed by discussion). Gas Wld—Nov. 14. 5600 w. 30 cts.

9369. Regenerator Furnaces for Small Gas Works. W. B. Randall (Read before the So. Dist. Assn. of Gas Engs. & Mangrs. Describes furnaces and their workings; clinkering; effect upon residuals, &c., and is followed by discussion). Gas Wld—Nov. 14. 4800 w. 30 cts.

9407. Trials of Gas Stoves (A summary of the more important results of a number of trials of heating with gas stoves, of which reports have been published by A. von Ihering, in the "Joural fur Gasbeleuchtung"). Jour of Gas Lgt—Nov. 17. 2000 w. 30 cts.

9483. The Use of Gas for Domestic Lighting. Vivian B. Lewes (Society of Arts, Cantor Lecture. The principles of illumination and the measurement of light—illuminating value and illuminating effect—domestic lighting—flat flame, argand and regenerative burners are discussed). Pro Age—Dec. 1. 7300 w. 15 cts.

9484. Studies of the Explosive Properties of Acetylene. Messrs. Berthelot and Violle (Extracts from the proceedings of the Academie des Sciences. A study of the precise conditions under which the explosive properties were susceptible of manifesting themselves). Pro Age—Dec. 1. 2200 w. 15 cts.

9631. The New Four-Lift Holder of the New York Mutual Gaslight Company. Walter A. Allen (Description of gasholder having a capacity of 4,500,000 cubic feet). Am Gas Lgt Jour—Dec. 7. 1800 w. 15 cts.

SEWERAGE.

9466. The Purification of Sewage by Filtration. Henry Law (Read at the Sanitary Inst. Congress. The filtration of sewage when the insoluble solid matters have been removed by previous precipitation is considered). San Rec—Nov. 20. 1800 w. 30 cts.

9552. Progress Made in the Purification of the Sewage of Paris. J. F. Flagg (Descriptive account of improvements being made for the purification of all the sewage of Paris before admitting it into the Seine). Eng Rec—Dec. 5. 5000 w. 15 cts.

STREETS AND PAVEMENTS.

9501. Specifications for Repair of Asphalt Pavements (Gives the specifications for repair during the year 1896 of asphalt pavements in Buffalo). Munic Engng—Dec. 1200 w. 30 cts.

9534. Street Commissioner Waring's Tour of Observation in Europe. George E. Waring, Jr. (Part first deals with street cleaning in Vienna). Harper's Weekly—Dec. 5. Serial. 1st part. 2000 w. 15 cts.

WATER SUPPLY.

9206. An Overlooked Stand-Pipe Incident at Atlantic City, N. J. (An account of a narrow escape from destruction of a stand-pipe. The incident as related by Mr. George T. Prince and Mr. E. Graves). Eng News—Nov. 12. 1400 w. 15 cts.

9224. Filtration. S. A. Charles (A description of the filter plant at Lexington, Ky. The mechanical filter in use there is said to be entirely satisfactory). Fire & Water—Nov. 14. 2400 w. 15 cts.

9225. New York's Water Supply (Facts of interest regarding the storage capacity of the city, the amount of rainfall and the future prospects). Fire & Water—Nov. 14. 1200 w. 15 cts.

9280. The Control and Supervision of Public Water Supplies by Sanitary Authorities. C. Porter (Abstract of a paper read at the Congress of the Sanitary Institute at Newcastle-on-Tyne. Considers some of the principal powers and duties of sanitary authorities). San—Nov. 2500 w. 45 cts.

9281. Sand Filtration. Allen Hazen (Report to the Women's Health Protective Assn. concerning a practical plan for sand filtration as a means of securing a better water supply for the city of Philadelphia). San—Nov. 6000 w. 45 cts.

9417. Removal of Iron from Water from a Filter Gallery at Reading, Mass. (An outline of investigations made, with illustrated description of the process in use, which consists of the addition of milk and lime, combined with thorough aeration and rapid filtration). Eng News —Nov. 26. 4700 w. 15 cts.

9440. Meerut Water-Works (Brief account, with general plan of site). Ind Engng—Oct. 24. 800 w. 45 cts.

9453. Some Observations on the Relation of Light to the Growth of Diatoms. George C. Whipple (Presents the results of a series of experiments made during the past year with a view to determining the nature and effect of influences which relate to the growth of diatoms in lakes and ponds). Jour of New Eng Water-Works—Sept. 5000 w. 75 cts.

9454. Making Cast Iron Pipe. Jesse Garrett (The subject relates to the best means of distributing water to the community. The history of lead, wood, stone and iron pipes is briefly reviewed and illustrated. The manufacture of cast-iron pipe is described and coating discussed). Jour of New Eng Water-Works. Sept. 12000 w. 75 cts.

9455. The Financial Management of Water-Works. Freeman C. Coffin (Statistics dealing with municipal works only. The need of a consistent and generally accepted theory of management is shown and the nomenclature of water-works management is defined. Discussion follows). Jour of New Eng Water-Works—Sept. 13000 w. 75 cts.

9491. The Water Supply of Philadelphia: Considered with Reference to the Minimum Flow of the Schuylkill River. Edwin F. Smith (The conditions of the water supply are set forth with tabulated statistics bearing upon the relations existing between the maximum consumption of water and the minimum flow of the river. Followed by discussion). Pro Engs' Club, of Phila—Nov. 5500 w. 45 cts.

9531. Meerut Water-Works (A short description of the plant, with illustration). Ind Engng—Oct. 31. 600 w. 45 cts.

9611. The Danube Tunnel of the Budapest Water-Works (Der Donautunnel des Wasserwerkes von Budapest). Josef Schusfber (Explains the construction and gives the various quantities of water supplied by the various springs). Deutsche Bauzeitung. Oct. 24, 1896. 3000 w.

MISCELLANY.

9197. The Incandescent Fire-Mantel. T. E. Pye (Read before the Midland Assn. of Gas Managers, Eng. Describes an appliance designed to facilitate the combustion of non-bituminous fuel in the ordinary domestic fire grate. It claims to give a smokeless fire at about half the expense usual, and while it can be used with all fuel, it is especially adapted to gas-works coke. Also discussion). Jour of Gas Lgt—Nov. 3. 2800 w. 30 cts.

9223. Scavenging, with Special Reference to Rural Districts. George Mackay (Its importance and effect upon the health and comfort of the community, with description of system recommended). San Rec—Nov. 6. 3500 w. 30 cts.

9277. The Work of the Massachusetts State Board of Health for 1895 (A review of the year's work, which contains valuable information for hydraulic and sanitary engineers). Eng Rec—Nov. 14. 1600 w. 15 cts.

9286. What Sanitation Has Done for Life (Extracts from address of Prof. Brewer, of Yale Univ., showing that life has been prolonged, especially in cities). Safety V—Nov. 1000 w. 15 cts.

9335. Recent City Engineering in Chicago, Ill. (An account of work and costs). Eng Rec—Nov. 21. 700 w. 15 cts.

9458. The Problem of the City. Clinton Rogers Woodruff (A discussion of what good city government is in certain directions. The importance of an abundant supply of pure water, drainage, street-cleaning, transportation, &c., is presented, and examples of European cities given, with other matters of related interest). Am Mag of Civ—Nov. 3500 w. 30 cts.

9492. The Cement Laboratory of the City of Philadelphia. Its Equipment and Methods. Richard L. Humphrey (Illustrated description of laboratory for testing and inspecting the cement used in municipal work. Apparatus explained in detail, and system used.) Pro Engs' Club of Phila—Nov. 9500 w. 45 cts.

9566. Refuse Destructor at Leyton (Illustrated description of plant designed to burn unscreened town's refuse and compressed sludge). Engng—Nov. 27. 1300 w. 30 cts.

RAILROADING.

NEW CONSTRUCTION.

9154. Railroad Building and Manganese Mining in Colombia. Ill. Eduardo J. Chibas (Describing the methods and experiences of the Caribbean Manganese Co. in the Department of Panama). Eng Mag—Dec. 3000 w. 30 cts.

9208. The Great Siberian Railway (Attention is called to the importance of the undertaking, and a brief description of the project is given, with map). Eng, Lond—Nov. 6. 1800 w. 30 cts.

9240. The Glasgow Subway and Cable Traction (An illustrated description of this line, about to be opened for public traffic. It is 6 1-2 miles long, entirely under ground, and particularly interesting because of some novel methods adopted in boring the tunnels, and in view of the fact that the cable traction plant installed is one of the largest and probably the most complete yet laid down). Engng—Nov. 6. Serial. 1st part. 4000 w. 30 cts.

9247. Delagoa Bay—Pretoria Railway (Map and section, with a few particulars). Ind Engng—Oct. 10. 500 w. 45 cts.

9249. The Budapest Subway Railway. J. Kollmann (Abstract from an article in the Elektrotechnische Rundschau (Brief description of a road built for the exhibition that it seems probable will remain in use). Elect'n—Nov. 6. 1000 w. 30 cts.

9320. The Trans-Siberian Railway (The information from which this article has been prepared has been collected from Russian Government publications, U. S. Consular reports, the technical press and the proceedings of various engineering societies, and only in the case of government publications does it bear the stamp of official authority, but as a description of the broad, general features of the work it is believed to be substantially accurate). Eng News—Nov. 19. 4400 w. 15 cts.

9327. The Central London Railway. C. H. Grinling (An account of the formation of the company, with description of the road, which is to be 6 1-2 miles in length and to have 14 stations. An underground electric road). R. R. Gaz—Nov. 20. 2800 w. 15 cts.

9361. Under-Tunnelling the District Railway (Report of Sir Benjamin Baker on the proposed electric express line of railway beneath the existing Metropolitan District system). Arch, Lond—Nov. 13. 1500 w. 30 cts.

9378. A Light Railway at Eaton Hall. From the London Times (Particulars respecting a light railway recently completed in the Duke of Westminster's estate for connecting it with the Great Western Railway, three miles distant). Prac Eng—Nov. 13. 1000 w. 30 cts.

9447. The New Railway to the Derbyshire Coalfields (A few of the principal features of the project and a description of the work). Trans—Nov. 20. 4800 w. 30 cts.

9572. Lancashire, Derbyshire and East Coast Railway, and the Sheffield District Railway (Illustrated description). Eng, Lond—Nov. 27. 1300 w. 30 cts.

9619. New Harbor Railway at Bristol (Nature and extent of the proposed undertaking, with map). Trans—Nov. 27. 1000 w. 30 cts.

ELECTRIC AND STREET RAILWAYS.

9188. A Model Electric Railway Plant (Illustrated description of a very complete plant located in New Haven, Conn., and belonging to the Fairhaven and Westville R. R. Co.). Sci Am Sup—Nov. 14. 1400 w. 15 cts.

9250. A Railway Power-House Transformed (Illustrated description of the plant of the Cicero and Proviso Street Railway Co. in the western suburbs of Chicago). W Elec—Nov. 14. 600 w. 15 cts.

9270. Clontarf Electric Tramway (Illustrated description of the extension of the Dublin United Tramway Co.'s electric system). Ry Wld—Nov. 900 w. 30 cts.

9284. Compressed-Air Surface Cars in New York (Favorable comment on the trials of the system recently made in New York). Safety V—Nov. 1200 w. 15 cts.

9294. The Jungfrau Mountain Electric Railway, Switzerland (Illustrated description of the route, method of construction and operation, the electrical work, &c.). Elec Eng—Nov. 18. 1800 w. 15 cts.

9295. The Institute Discussion on Electric Traction Under Steam Railway Conditions. Dr. Charles E. Emery (The writer discusses the various phases of the subject and concludes that the application to long trunk lines does not seem practicable under present conditions). Elec Eng—Nov. 18. 3600 w. 15 cts.

9402. The Influence of Rails on Street Pavements. Edward P. North (Discusses the kinds of rails in use in various localities, their advantages and defects; also the satisfactory adjustment of the pavement to the rails, and the condition of the space between the rails). Am Soc of Civ Engs—Nov. 2200 w. $1.

9403. Car Tracks and Pavements. James Owen (Discusses the relation of

the owner of the railway to the authorities in charge of the highway, and the general subject, both in city and suburbs). Am Soc of Civ Engs—Nov. 2500 w. $1.

9405. Electric Traction Under Steam Railway Conditions (Full discussions in New York and Chicago opened by Dr. Charles E. Emery). Trans Am Inst of Elec Engs—Oct. 23500 w. 45 cts.

9512. The Englewood and Chicago Storage Battery Railway (Illustrated description of a road recently put into operation). Elec Eng—Dec. 2. 1700 w. 15 cts.

9527. The Electric Railway of Varese, Italy (Brief history of the undertaking with illustrated description). St Ry Jour—Dec. 1500 w. 45 cts.

9529. Niagara Power for the Buffalo Railway System (Illustrated description of the system). St Ry Jour—Dec. 2800 w. 45 cts.

9530. A Novel Electric Railway in Fairmount Park, Philadelphia (Descriptive account). St Ry Jour—Dec. 1500 w. 45 cts.

9629. A Railway Through the Sea (Illustrated description of a novel electric railway which Mr. Magnus Volk has carried to a successful issue at Brighton, Eng.). Elec Rev, Lond—Nov. 27. 1400 w. 30 cts.

9648. Motor Cars on the Brooklyn Bridge (Illustrated description of the electrical equipment). Elec Eng—Dec. 9. 1500 w. 15 cts.

EQUIPMENT AND EQUIPMENT MAINTENANCE.

9161. The Standard Wheel Tread and Flange (Discussion of the suggestion of J. N. Barr at the last annual convention of the Master Car Builders, and advising the getting the rails into a proper shape rather than attempt any modification of the wheel tread. Also a letter on the subject from George S. Hodgins). RR Car Jour—Nov. 2300 w. 15 cts.

9186. A. Balanced Locomotive (Illustrated description of the Strong balanced locomotive, formerly the A. G. Darwin). Sci Am—Nov. 14. 1200 w. 15 cts.

9213. Narrow Gauge and Mountain Locomotives, Bosnia and Herzegovina State Railways (Illustrated description and general information. Eng, Lond—Nov. 6. 2000 w. 30 cts.

9242. Heavy Goods Locomotive for the New South Wales Railways (Illustrated description, with principal dimensions). Engng—Nov. 6. 1000 w. 30 cts.

9269. The Barsi Light Railway Exhibition (Illustrated description of the rolling stock which was shown at Newlay. Ry Wld—Nov. 1800 w. 30 cts.

9271. Cars for Narrow-Gauge Tramways (Illustrations of a type of car specially constructed for small narrow-gauge tramways). Ry Wld—Nov. 400 w. 30 cts.

9274. The New Master Car Builders' Axle for 80,000 lb. Cars (An explanation and summary of the work of the committee which directly affected the design of the axle between wheel hubs). RR Gaz—Nov. 13. Serial. 1st part. 2000 w. 15 cts.

9282. Locomotive Boilers and Tubes (Extract from report by Ed Sauvage at the last meeting of the International Railway Congress). It is practically a condensed statement of the report). Safety V—Nov. 1000 w. 15 cts.

9329. New 60-ft. Postal Cars for the St. Louis, Iron Mountain & Southern Railway (Description and drawings). R R Gaz—Nov. 20. 500 w. 15 cts.

9414. Heavy Tank Locomotive for the Madison Incline. Pennsylvania Line (Illustrated description, with dimensions and particulars). Eng News—Nov. 26. 1700 w. 15 cts.

9488. Cast-Iron and Steel-Tired Wheels. R. C. P. Sanderson (From a paper before the Southern and Southwestern Ry Club. Briefly touches the questions of safety, weight, running qualities, rail wear and cost). Eng, Lond—Nov. 20. 2000 w. 30 cts.

9503. The First Railroad Engine (The article claims that Edward Entwistle, the man who ran it, is still living in Des Moines, Iowa. Brief account of first trip). Bos Jour of Com—Nov. 28. 1500 w. 15 cts.

9550. Three New Metallic Car Trucks (Illustrated descriptions of the Standard truck, the L. & N. freight truck, and the Buckeye truck). Ry Mas Mech—Dec. 1700 W. 15 cts.

9588. Baltimore and Ohio 60,000-Pound Box Car (Illustrated description). Loc Engng—Dec. 700 w. 30 cts.

9596. Grate for Burning Fine Anthracite Coal—Delaware, Lackawanna and Western Railroad (Illustrated description of grate for burning hard coal on engines. Designed by David Brown). Am Eng & R R Jour—Dec. 500 w. 30 cts.

MAINTENANCE OF WAY AND STRUCTURE.

9610. Changes in the Form and Position of Rails (Verande rungen in der Lage und Form des Eisenbahn gestanges). By Braunig in Kosln. (An exhaustive experimental investigation on the changes produced in the form and position for a long term of years and all conditions of weather). Zeitschrift fur Bauwesen, x-xii. 10500 w.

TERMINALS AND YARDS.

9480. Terminal Yards. H. G. Hetzler

(Shows the importance of giving attention to the arrangement so that business can be handled with the least expense and delay possible. Discusses details, and is followed by discussion). Jour W Soc of Engs—Oct. 4800 w. 45 cts.

9622. Chesapeake and Ohio Improvements. A. E. Coulter (An illustrated description of the new connections, yards and terminals at Richmond, Va.) Ry Age—Dec 4. 5000 w. 15 cts.

TRANSPORTATION.

9339. Gross and Net Railway Earnings (Returns for September and nine months of the present calendar year. Classified statements). Bradstreet's—Nov. 21 1000 w. 15 cts.

9387. American Lessons in Cheap Railroad Transport (Editorial considering the benefits to American industries arising from American railroads and the cheap transport as compared with Great Britain). Ir & Coal Trds Rev—Nov. 13. 900 w. 30 cts.

MISCELLANEOUS.

9152. High-Speed Standards of Men, Machinery and Track. H. G. Prout (Showing that the fast running of trains necessitates improvement in methods and material, and has a disciplinary effect on trainmen). Eng Mag—Dec. 3000 w. 30 cts.

9162. National Electric System of Car Lighting (Illustrated description of the system of this company, which is the result of the investigations and experiments of Mr. Morris Moskowitz). R R Car Jour—Nov. 1200 w. 15 cts.

9163. Car Lubrication. A. M. Knapp (Causes of hot box delays and suggestions for avoiding them). R R Car Jour—Nov. 1500 w. 15 cts.

9204. Reports on the Modified Routes for the New York Rapid Transit Railway (Illustrated description of the new plan, which differs from the old chiefly in comprising only those lines that are immediately necessary, and the substitution of the Elm street route for the Broadway lines between City Hall and Union Square). Eng News—Nov. 12. 5000 w. 15 cts.

9273. Rapid Transit in New York (A free abstract of the report of the chief engineer, with map and profile, and some typical sections; also editorial comment). R R Gaz—Nov. 13. 3500 w. 15 cts.

9315. Train accidents in the United States in October (Classified table with summary). R R Gaz—Nov. 20. 4500. 15 cts.

9315. On the Adoption of a Universal Standard for Rating Railway Apparatus. William Baxter, Jr. (A discussion of the subject and its importance, and the objections in the case of electric equipment. Also the fields in which standards would be of advantage). Elec Wld—Nov. 21 2200 w. 15 cts.

9328. Train Accidents in the United States in October (Classified table with summary). R R Gaz—Nov. 20. 4500 w. 15 cts.

9331. The Steam Trolley Contest in Connecticut (Editorial comment on the decision rendered by Judge G. W. Wheeler in the Superior Court of Conn.). R R Gaz—Nov. 20. 1500 w. 15 cts.

9388. Hydraulic Attachment for Raising Rotary Snow Ploughs (Illustrated description of an attachment for raising the end of the machine complete). Ry Rev—Nov. 21. 700 w. 15 cts.

9389. Liability Release Clause in Railroad Companies Ground Lease. W. L. Barnum (From a paper read at the meeting of the Grain Dealers' National Assn. A discussion of the obligations of railroad companies to grain dealers in relation to elevators for shipping grain). Ry Rev—Nov 21. 2800 w. 15 cts.

9523. Inclined Planes. Samuel Diescher. (From a paper read before the Soc of Engs of W Penna. The first part discusses types and features, compares with cable and electric roads, the balance system, safety devices, connection between engine and drum, drums and peculiar accidents). Ir Age—Dec. 3. Serial, 1st part. 3000 w. 15 cts.

9528. Piece Work in Repair Shops. C. F. Uebelacker. (States the conditions which led to the adoption of the piecework system, how the problem of working up a price list was solved, and general details of the work. The advantages and disadvantages are cited). St Ry Jour—Dec. 3000 w. 45 cts.

9530. The Electrically Welded Continuous Rail. Richard Eyre. (The merits of the electrically welded track are shown, and the difficulties that have been conquered in bringing it to its present degree of perfection are discussed). St Ry Jour—Dec. 3300 w. 45 cts.

9538. Relative Steam-making Capacity of Firebox and Tube Surface. (Letters containing inquiry about a statement in RR Gaz to the effect that one square foot of firebox heating surface of a locomotive boiler would make as much steam as ten square feet of average tube-heating surface, are replied to at length, and diagrams given). RR Gaz—Dec. 4. 2700 w. 15 cts.

9539. Compressed Air in the Shops of the Union Pacific Railroad at Omaha. H. N. Latey. (Illustrated description of what the writer considers an ideal system). RR Gaz—Dec. 4. 2000 w. 15 cts.

BOOKS OF THE MONTH

BOOK NOTICES.

STURGIS, RUSSELL. EUROPEAN ARCHITECTURE. A Historical Study. The Macmillan Co., New York, 1896. Cloth, $4.

The monuments of architectural art are herein made the subject of minute personal study by a critical writer of authoritative standing in the architectural profession. Documents are referred to only for verification of dates, or for the procuring of data once recorded, but no longer available through the decay and dilapidation of structures. Some such structures have so far perished that they can be reconstructed only by mental processes. The history begins with the sixth century before Christ, and is brought down to the time of the French revolution. The work contains nine chapters, the later ones dealing with architecture in France, Germany, and Italy.

LONERGAN, WALTER F. HISTORIC CHURCHES OF PARIS. With Drawings by Brinsley S. Le Fanu, and from Photographs. T. Whittaker, New York, 1896. Cloth, $6.

Twenty-four churches are described:—Notre Dame, Sainte Chapelle, and St. Denis in an extended way proportional to their historical interest. There are some fifty illustrations of the churches and their contents. While the architectural features are not neglected, the historical features are given more prominence. One of the most valuable parts of the book is an index of authors who have written of these churches and their various attractions, architectural and otherwise.

PIERCE AND RICHARDSON, ELECTRICAL ENGINEERS. THE National Electrical Code. Charles A. Hewitt, Chicago, 1896. Flexible morocco, pocket-book style. $2.

A successful attempt to present such an analysis of the underwriters' National Electrical Code as will be intelligible to non-experts. It is a reprint of articles originally published in the *Insurance Post* of Chicago, in response to many requests. A full table of contents is given, but a thorough index, which is lacking, would have added very much to the convenience and value of the book.

HOWE, MALVERD A. RETAINING WALLS FOR EARTH. Third edition, revised and enlarged. John Wiley & Sons, New York, 1896. Cloth, $1.25.

Includes the theory of earth-pressure as developed from the ellipse of stress. Also contains a short treatise on foundations, illustrated with examples from practice. The latter replaces the appendix of the second edition. The demonstrations have been made shorter by basing them upon the theory of the ellipse of stress advanced by Prof. Rankine in 1858, instead of retaining those of Prof. Weyrauch employed in the first edition. The latter are presented in an appendix to the present edition, and the results of the shorter method are thus shown to be identical with those obtained by Weyrauch. The labor of substitution in the formulæ has been much lessened by computation and tabulation of coefficients.

MARQUAND, ALLAN, AND FROTHINGHAM, ARTHUR L., JR. A Text-book of the History of Sculpture. Longmans, Green & Co., New York. 1896. Cloth.

THE third of the series of college histories of art, edited by John C. Van Dyke, professor of the history of art in Rutgers College, and published by this house. The book forms a fitting sequel to the "History of Painting," by Prof. Van Dyke, and the "History of Architecture," by Prof. Alfred D. F. Hamlin of Columbia University, which have preceded it. The authors, in the preface, give as a reason for not including prehistoric sculpture in the scope of a work intended for students in schools and colleges that the want of connection of that sculpture "with the flow of civilization is at present too remote and ill defined." Saracenic, Indian, Chinese, and Japanese sculpture are also excluded, as being, "from a historical standpoint, in great measure still a mystery to the western world." The work is planned as an aid to the study of sculpt-

ure through casts and photographs; and lists of addresses for photographs and casts, respectively, are presented. The history begins with Egyptian sculpture, and proceeds through Babylonian, Assyrian, Persian, Hittite, Phœnician, and Cypriote sculpture to the Greek, two chapters being assigned to Egyptian, and one to each of the others. Four chapters are assigned to Greek sculpture, one to Italian and Etruscan, and one to Roman. Early Christian and Byzantine sculpture are dealt with in a single chapter. Three chapters are devoted to medieval sculpture,—Italy, France, and Germany having each a chapter. Four chapters are taken up with the history of renaissance sculpture in Italy (1500 A. D. to 1800 A. D.), one chapter with renaissance sculpture in France, and one with renaissance sculpture in Germany, The Netherlands, Spain, and England. Four chapters are then devoted to modern sculpture in Italy, Denmark, Sweden, Germany, Russia, France, England, and the United States. This enumeration sufficiently displays the method of the book, in respect of classification; but there is also a further sub-division into periods of art. With the history of each of the classes of sculpture named there is given a valuable list of books recommended for reading. The book is handsomely printed on coated paper, and the illustrations are numerous and excellent.

WILLIAM, JASPER NICOLLS. THE STORY OF AMERICAN Coals. J. B. Lippincott Co., Philadelphia. 1896. Cloth.

THE author has here successfully brought together a mass of information which hitherto could be found only in scattered books, some of which are out of print. American coals only are treated. The author is a mining engineer of fifteen years' experience in Pennsylvanian coal-fields. Part I of the book contains, under the general division of the origin of American coals, eight chapters. Part II treats of the development of the mines, in eight chapters. Part III deals with the subject of transportation, also in eight chapters, and nine chapters in Part IV are concerned with the subject of consumption. The treatise is singularly free from technicalities, and is written in popular style without much sacrifice either of accuracy of statement, or conciseness. Any lay reader interested in the industries of the country may peruse the work with pleasure and profit.

WESTON, EDMUND B. TABLES SHOWING LOSS OF Head due to Friction of Water in Pipes. D. Van Nostrand Co. New York. 1896. Flexible morocco; pocket-book form. $2.

The tables show (1) the loss of head due to friction of water in pipes having very smooth interior sides (*e. g.*, pipes of lead and brass), and (2) loss of head due to friction in pipes of rough interior,—for example, new cast-iron pipes. Description of the tables, examples, and supplementary tables are supplied. The latter give (1) theoretical velocities for use in obtaining results beyond the highest limits of table No. 1; (2) theoretical velocities for use in obtaining results beyond the highest limit of table No. 2; and (3) constants for different diameters to be used for extending table No. 2, and in obtaining results beyond the highest limits of that table. The tables are printed in clear, bold type, and are very handy for practical use.

ROBINSON, STILLMAN W. PRINCIPLES OF MECHANISM. A Treatise on the Modification of Motion by Means of the Elementary Combinations of Mechanism, or of the Parts of Machines. First edition. John Wiley & Sons, New York. 1896.

An important addition to the literature of mechanical engineering, intended for the use of colleges and mechanical engineers, who will find in it, not a historical treatise, but a thorough discussion of the underlying principles of mechanism for transmitting and changing the direction and velocity of motion. A machine is defined at the outset as "a combination of fixed and moving parts or devices, so disposed and connected as to transmit or modify force and motion for securing some useful result." The fixed parts are regarded as a class, separate from the moving parts. The moving parts are categorically classified as revolving shafts; revolving wheels (with or without teeth); rods or bars with reciprocatory or vibratory motion, or both; flexible connectors depending on friction; flexible connectors independent of friction; and a column of fluid in a pipe. Very likely this classifica-

tion may be deemed imperfect by some critics, and not sufficiently comprehensive by others; but in his derivation of trains of mechanism upon the basis of the classification the author has succeeded in very plainly elucidating principles, and has elaborated a good and useful book, which the publishers have printed, illustrated, and bound in their usual fine style of printing.

RAYMOND, WILLIAM G. A TEXT-BOOK OF PLANE SURVEYING. American Book Co., New York. 1896. Cloth. $3.

A manual for the study and practice of surveying, in which the long experience and practice of the author in the field has been combined with a similarly prolonged experience in the class-room as an instructor in one of the best technical schools in the land. Modern methods, clear and concise statements, and definite directions are features which even the most cursory examination discloses. The book is unusually well illustrated for a treatise of the kind. The tables are printed on tinted paper, which distinguishes them from the rest of the work and facilitates reference.

The logarithmic tables are carried out to five places of decimals, and the type and paging are so arranged that all numbers beginning with a given figure can be found without turning the page. The arrangement of tables, of sines, cosines, etc., is for tenths of a minute, instead of for seconds,—a method regarded as more serviceable both for practical and theoretical use. Another feature is that of colored maps finished as in actual practice. Altogether a good and carefully-prepared book.

BOOKS ANNOUNCED.

Gardenier, Norman. Ready Help for Locomotive Engineers and Firemen. D. McKay, Philadelphia. 1896. Cloth, $1.

Roper, Stephen. Care and Management of the Steam Boiler. New Issue. D. McKay, Philadelphia. 1896. Morocco, $2.

Roper, Stephen. Catechism of High Pressure Steam Engines. New issue. D. McKay, Philadelphia, 1896. Morocco, $2.

Roper, Stephen. Engineers' Handy-book. New issue. D. McKay, Philadelphia. 1896. Morocco, $3 50.

Roper, Stephen. Handbook of Land and Marine Steam Engines. New issue. D. McKay, Philadelphia. 1896. Morocco, $3.50.

Roper, Stephen. Handbook of the Locomotive. New issue. D. McKay, Philadelphia. 1896. Morocco, $2.50.

Roper, Stephen. Handbook of Modern Fire Engines. New issue. D. McKay, Philadelphia. 1896. Morocco, $3.50.

Roper, Stephen. Instructions and Suggestions for Engineers and Firemen. New issue. D. McKay, Philadelphia. Morocco, $2.

Roper, Stephen. Questions and Answers for Engineers. New issue. D. McKay, Philadelphia. 1896. Morocco, $3.

BOOKS RECEIVED.

Fowler, William H., Editor. Practical Engineer Pocket-Book for 1897. Technical Publishing Company, L't'd., Manchester, England. 1896. Leather, gilt with diary on ruled section paper, post free, 1s. 8d.; cloth, without diary, post free, 1s. 2d.

Hogg, Prof. Alex., M.A. Special Edition Revised and Enlarged. With New Illustrations. Prof. Alex. Hogg, Superintendent of Schools, Fort Worth, Texas. 1897. Paper.

Converse, John H., A.B. Citizenship and Technical Education. Address delivered on Founder's Day (October 8, 1896). John H. Converse, Philadelphia. 1896. Paper.

Hild, William R. Seventh Annual Report of the Syracuse water board to the mayor of the city of Syracuse, for the year ending June 30, 1896. Paper.

Department of Crown Lands, Toronto. Fifth Report of the Bureau of Mines. Maps, geologically colored and compiled from plans of survey by the department of crown lands, and plans of survey by the geological survey department, Ottawa, exhibiting parts of the Rainy River district near Rainy Lake, and River Seine, and of the country in the vicinity of Manitou, Wabigoon, and Eagle Lakes.

Vogdes, Anthony W., Capt. Fifth Artillery, U.S.A. A Bibliography relating to the geology, paleontology, and mineral resources of California. Bulletin No. 10 of the California State mining bureau. J. J. Crawford, State Mineralogist, San Francisco. 1896.

Behr, Hans C., Mechanical Engineer. Mine Drainage, Pumps, etc. Bulletin No. 9, California State mining bureau. J. J. Crawford, State Mineralogist, San Francisco. 1896.

Tenth Annual Report of the Commissioner of Labor. 1894. Strikes and Lockouts, Volume II., Summaries of Strikes and Lockouts. Government Printing Office, Washington, D.C. 1896.

Fifth Report of the Bureau of Mines. 1895. Printed by order of the Legislative Assembly of Ontario. Warwick Bros. and Rutter, Printers, Toronto. 1896.

Twenty-Seventh Annual Report of the State Board of Health of Massachusetts. Public document No. 34. Cloth, 807 pp.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

R. D. Wood & Co. Philadelphia, Pa., U.S.A. =Pamphlet illustrating and describing the Taylor gas producer, gas fuel, and the application of producer gas to manufacturing purposes.

The Waterbury Farrel Foundry and Machine Co. Waterbury, Conn., U.S.A.=(*a*) Leaflet containing Index of 1897 Catalogue. (*b*) Pamphlet containing illustrations of newly-designed machines used in the manufacture of sheet-metal goods. (*c*) Leaflet illustrating and briefly describing five styles of tube-and rod-drawing machinery.

Michigan Mining School, Houghton, Mich.= Catalogue for 1894-1896, with statements concerning the institution and its courses of instruction, which comprise an eclectic system claimed to be different from any other technical school.

The Bristol Company, Waterbury, Conn.= Circular illustrating and describing a partial list of the Bristol recording instruments for pressure, temperature, and electricity.

Ross and Co. London, Eng.=(*a*) Catalogue and price-list of telescopes and binocular glasses. (*b*) Pamphlet illustrating and describing new photographic lenses for 1896. (*c*) Pamphlet illustrating and describing the Ross new patent Science Lantern arranged for use vertically, or for parallel beam work.

Robert Poole and Son Co., Baltimore, Md., U.S.A.=New gearing list. Larger and more complete than heretofore issued. Includes both machine-moulded gears, and cut gears of all kinds, from the smallest up to fifty feet in diameter.

School of Mining and Agriculture, Kingston, Ontario.=Calendar of the fourth session, 1896-1897.

The Cutter Electrical and Mfg. Co., Philadelphia, Pa., U.S.A.=Engineers' Edition of Catalogue and Data Book of the "I. T. E." (inverse, time element) automatic circuit breaker for various purposes and for both direct and alternating current circuits.

Betts Machine Co., Wilmington, Delaware, U.S.A.=(*a*) Illustrated pamphlet describing planing machines of different sizes and styles. (*b*) Pamphlet illustrating and describing boring and turning mills.

Colorado Iron Works Co., Denver, Colorado, U.S.A.=Pamphlet illustrating and describing ore-crushing machinery, for concentration, amalgamation, cyanide, chlorination and smelting plants, and other mining, milling, and smelting equipment.

P. Blaisdell & Co., Worcester, Mass., U.S.A. =Catalogue (1896) of Machinists' Tools, illustrating and describing patent upright drills with quick return, engine lathes, planers, boring mills, gear cutters, and hand-lathes.

J. T. Slocomb & Co., Providence. R. I., U.S.A.=Catalogue (1896) and price-list of Machinists' Tools, such as callipers, gages, micrometer gages, indicators, center drills, etc , etc.

Ranken & Fritsch Foundry and Machine Co., St. Louis, Mo., U.S.A.=Pamphlet illustrating and describing the Ranken-Fritsch Corliss Engines, and their details.

Morse, Williams & Co., Philadelphia, Pa., U.S.A.=Portfolio of plates with descriptive text of hydraulic, electric, steam belt, and hand-power elevators, dumb waiters, and general hoisting machinery.

U. Baird Machinery Company, Pittsburg, Pa., U.S.A.=Catalogue *B*, a large illustrated quarto of 656, 9"×12", pages, bound in stiff buckram cover. Illustrated descriptions and price-lists of very extensive and comprehensive lines of iron and wood-working machinery, machinists, supplies, etc.

I. P. Frink, New York.=Catalogue No. 26. Frink's patent reflectors for electric, gas, combination, and Welsbach lights.

Clayton Air Compressor Works, New York, U. S. A.=Circular supplementing Catalogue No. 8. The catalogue and the supplementary circular together include a long line of compressed-air tools and appliances, comprising in their illustrated descriptions all prominent and important compressed-air machines and devices, thus thoroughly and comprehensively representing the development of a mode of transmitting power now rapidly coming to the front as a rival to electrical transmission.

The Link-Belt Engineering Co. (Nicetown), Philadelphia, Pa., U. S. A.="Modern Methods," an octavo volume of 130 pages illustrating and describing the capabilities of the machinery for handling materials made by the firm, with cuts and price lists.

The Trenton Iron Co., Trenton, N. J.: Cooper Hewitt & Co., New York.=Volume of 164 pages illustrating and describing wire rope transportation in all its branches, including the "Bleichet," "Roe," and "Acme" patent systems, patent hoist conveyors for quarries, dam-building, open cut work, etc., and wire-rope outfits for shafts, inclined planes, power transmissions, etc.

Lehigh University. South Bethlehem, Pa., U. S. A.=(*a*) Pamphlet describing the course, in civil engineering, including history and plan; program of studies, drawing, surveying, construction and materials, sanitary and hydraulic engineering, bridge engineering, etc. (*b*) Pamphlet describing course in mechanical engineering. (*c*) Pamphlet describing courses of study in department of English language and literature, preparation required for admission, etc. (*d*) Pamphlet describing school of general literature—three courses—classical, Latin, scientific, and course in science and letters.

Massachusetts Institute of Technology, Boston, Mass. Pamphlet describing the course in mining engineering, and in metallurgy.

Fairbanks, Morse & Co., Chicago, Ill., U.S.A. = Pamphlet illustrating and describing the Fairbanks-Morse Gas and Gasolene Engines.

The Pope Tube Company, Hartford, Conn., U.S.A. = Illustrated pamphlet, describing the process and methods of steel tube making as conducted in this establishment, its facilities, and the qualities of the high class tubing made therein.

Rudolph & Krummel Machine Works, Chicago, Ill., U.S.A. = Catalogue of presses, dies, sheet-metal, and wire-working machinery, and special machinery for manufacturing bicycles.

Chas. J. Bogue, New York, N. Y., U.S.A. = Illustrated catalogue and price-list of American dynamos and lamp-parts for the "American" system of dynamos and arc lamps.

A. A. Griffing Iron Company, New York, N. Y., U.S.A. = Large illustrated pamphlet describing the "Bundy Sectional Tubular Heater."

The Colorado Iron Works Co., Denver, Colo., U.S.A. = Pamphlet entitled "Some Details as to Smelting Practice and Equipments for the Reduction of Gold, Silver, Lead, and Copper Ores."

The Connecticut Telephone and Electric Co., Meriden, Conn., U.S.A. = Catalogue and price-list of telephones, telephone equipment, and electrical supplies.

The Lehigh University, South Bethlehem, Pa. = Pamphlet describing courses of study in mining and metallurgy, stating the requirements for admission, and giving other information relating to adjunct technical engineering studies, etc.

A. A. Griffing Iron Company, New York, N. Y., U.S.A. = Pamphlet illustrating and describing the construction and operation of the "Bundy" return steam traps, tank traps, trap check valves, and trap receivers.

Thayer School of Civil Engineering, Dartmouth College. = Catalogue and price-list of books used in the schedules of the courses of instruction. Publishers' addresses are given. Titles of books considered indispensable to engineers, printed in small capitals. Books of special value indicated by an asterisk.

The Westinghouse Machine Company, Pittsburg, Pa., U.S.A. = (*a*) Beautifully illustrated pamphlet describing the "Westinghouse" steam engines with pictures of installations, testimonials, etc. (*b*) Similar pamphlet illustrating and describing the "Westinghouse" gas engines.

The Baker Gun and Forging Co., Batavia, N. Y. = "The Baker Gun Quarterly." An illustrated newspaper devoted to the description of several fine shot-guns which the company have just introduced. The firm makes a business of dealing directly with the users of their guns, and has issued the newspaper quarterly as a means of keeping in touch with patrons and replying to all general correspondence from sportsmen. A very useful paper.

Cahall Sales Department, Bank of Commerce Building, Pittsburg, Pa. = A very handsomely printed pamphlet giving six full-page views, with detailed description, of the Cahall vertical and the Babcock & Wilcox horizontal water-tube boilers manufactured by the Aultman & Taylor Machinery Co., Mansfield, Ohio.

American Blower Co., Detroit, Mich. = An elaborately illustrated and beautifully-printed catalogue of 210 pages, giving every possible detail of information with regard to the modern apparatus for heating, ventilating, and drying manufactured by this firm. It is one of the finest specimens of the printers' art ever issued; printed in three colors throughout; the very numerous engravings are made by Conant, and are exceptionally fine; the entire work is divided into 13 parts, each of which is readily accessible; and a great variety of new matter of interest to heating engineers, architects, and contractors is presented. A very valuable work. Sent free on application.

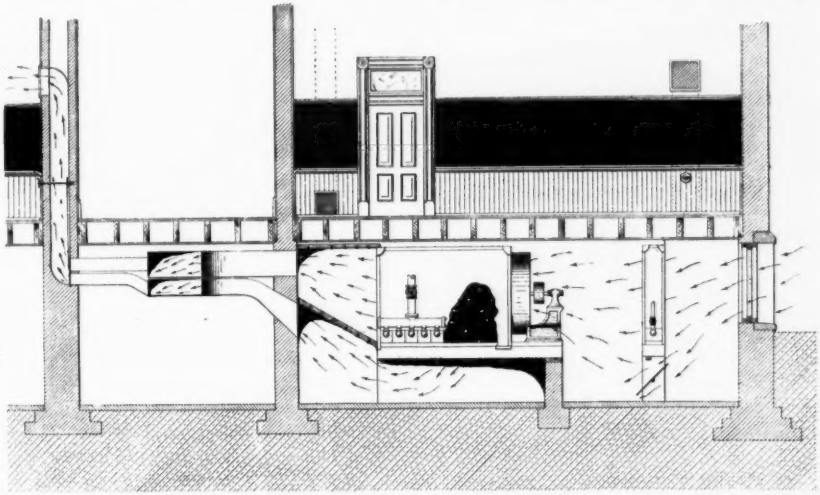
IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A Modern Heating and Ventilating Plant.

THE Cameron School, a handsome two-story structure recently erected at Harrisburg, Pa., has been equipped with a heating and ventilating plant which embodies a number of important features necessary to a perfect school house system. It is what is known as the hot-blast system, in which a fan is used to force the fresh air over a steam coil and thence into air pipes leading to the rooms to be heated.



SECTION THROUGH SCHOOL BASEMENT, SHOWING ARRANGEMENT OF APPARATUS.

The entire apparatus is placed in the basement, and so arranged as to require little floor space and be under the immediate control of the janitor. The fresh air enters the building through a large window provided for this purpose, and then passes through a tempering coil, which heats it to about 65 degrees. A disc-fan or blower, to which it then passes, is used for forcing this air either through or beneath the main heater coil, as required. During mild weather the air is not reheated, but passed beneath the coil and into the tempered-air pipe. The air thence enters the conduit pipes, which are suspended from the basement ceiling and which connect with the flues leading to the various rooms to be heated. The piping in the basement is double, the upper pipe being for hot air and the lower for tempered air; the former connects with the heater coil and the latter with the by-pass beneath it.

A separate fresh-air and vent flue is provided for each room, thereby avoiding any possible back draught, a very important point in schoolhouse heating. Mixing dampers, at the base of each fresh-air flue, are used for controlling the volume of hot or tempered air admitted to each room, and these are operated automatically, or by means of conveniently arranged hand regulators. All the air entering the building is heated to 65 degrees before it passes to the fan, thereby avoiding too rapid cooling, which would cause cold draughts and otherwise be objectionable.

The best authorities have determined that 30 cu. ft. of air per minute is the minimum that should be supplied to each pupil to properly dilute the vitiated air. The apparatus is, therefore, carefully designed to meet this specific requirement, namely, 30 cu. ft. of fresh air per minute, or 1800 cu. ft. per hour, to each pupil in the 12 school rooms; and it also changes the air in corridors and play rooms once every 20 minutes. There is an equal and constant air pressure on each system of piping, so that when a mixing damper is raised, shutting off the supply of hot air, a like volume of air enters the room from the tempered-air pipes, or vice versa. By means of this system a uniform temperature of 72 degrees may be maintained in the rooms at all times, regardless of the weather.

The air flues are built in the wardrobe walls, thus occupying no valuable floor space and avoiding disfiguration of the walls in the class rooms. The fresh air passes from the flue to the room through a pipe placed about eight feet above the floor, which is also the height of the air inlet. The air is discharged towards the opposite side of the room, setting all the air in motion, and it gradually falls to the floor and passes across to the vent outlet, which is placed directly beneath the fresh-air inlet. This vitiated air then passes into the wardrobes, thoroughly ventilating them; thence into the vent flues, which convey it to the attic, through a system of vent piping, which in turn connects with ventilators discharging the air through the roof.

The lavatories in the basement are heated by means of ceiling coils. Extra large ventilators are provided for removing the foul air, the fresh air entering from the corridors. The closets and urinals are each provided with a large hood, which is connected by means of a 16-inch pipe to a large vent flue. These hoods are of the full size of the closets, and the vent flues are provided with four gas burners for accelerating the draught. To avoid any possible back draught from these flues into the building, they are carried up through the roof, each being entirely separate from the vent piping.

The tempering and main heater coils are made up of "A B C" steam coils. A 60 H. P. Star water tube boiler is used for generating the steam, which is supplied to the heating surface at 5 lbs. pressure, making the plant a low-pressure one. A 5 H. P. electric motor is used for operating the fan, thus enabling the fan to be utilized for forcing cool air into the building during the summer, thereby reducing the temperature of the rooms from 10 to 15 degrees below the atmosphere,—a most desirable feature in a school-ventilating plant. A Marsh steam-pump is used for feeding the boiler and receiving the water of condensation from coils. This

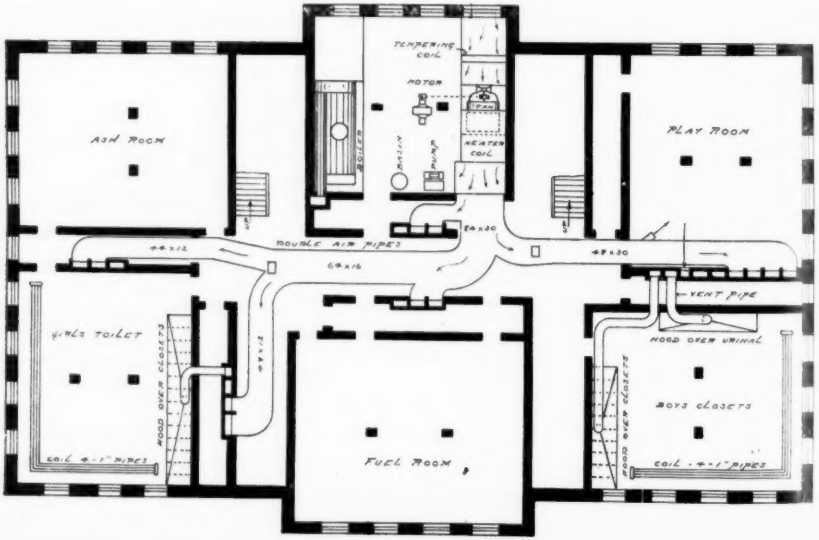
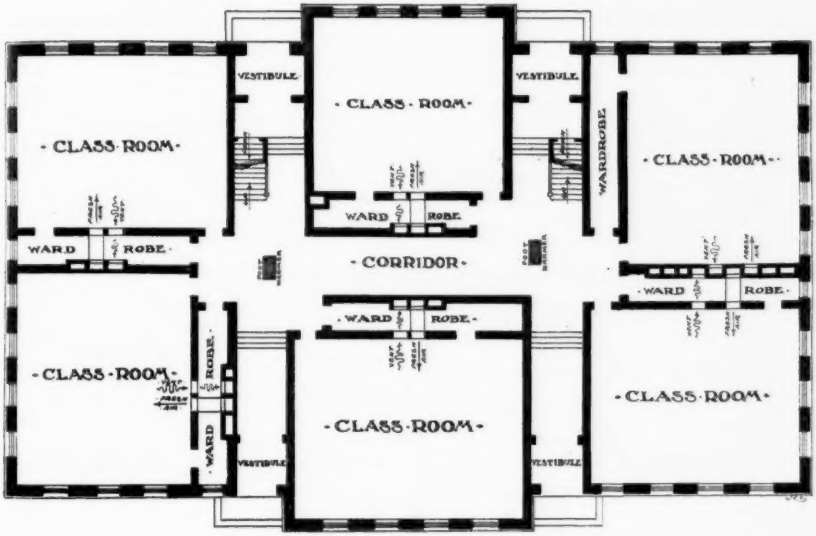


FIG. 1.—BASEMENT PLAN.



FIRST · FLOOR · PLAN ·
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water is usually at a temperature of 160 to 180 degrees, so that only a small amount of fuel is required to keep up steam; the boiler is therefore very economical in fuel consumption.

We think this description sufficient to enable any one to clearly understand the essential features of a modern heating and ventilating plant. The system described is applicable to all schools, large or small, and while it is somewhat more expensive than furnaces in first cost, yet, when the brickwork required for each system is taken into consideration, it is said to be considerably cheaper.

The American Blower Co., of Detroit, Mich., were the designers of the plant, and they furnished the apparatus and the plans and specifications, with a guarantee that the plant would fulfil the requirements; they, therefore, assumed all responsibility. But, agreeable to their policy of dealing through local heating firms, the contract was made through the Harrisburg Steam Heat & Power Co., who are the Harrisburg representatives of the American Blower Co.

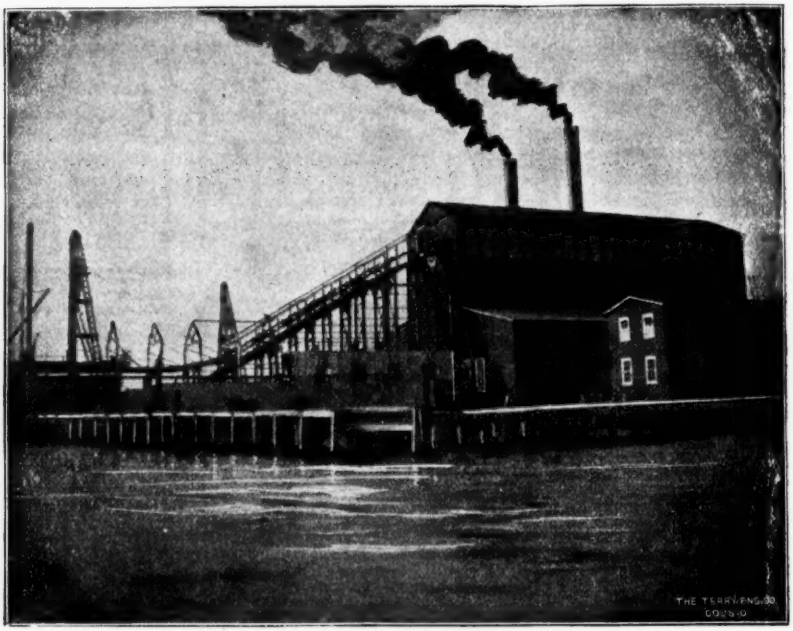
Air-Lift System of Pumping.

THE Wainwright Brewery, St. Louis, Mo., are to change their entire system of pumping, having made extensive tests during the past summer to determine the most efficient and economical method for their especial needs. The decision is in favor of the air-lift and direct air-pressure systems.

The air compressor for the low-pressure service (consisting of Halsey pneumatic pumps) will be a Rand cross-compound condensing engine with duplex air-cylinders, built by the Rand Drill Company, and of their latest improved type. A second compressor, built by the same company and of special construction, fitted with hooded heads, will take air at an initial pressure of about 50 lbs. from the main receiver, and compress to 125 lbs. for the air-lift system. The Pneumatic Engineering Company, 100 Broadway, New York, have the contract for the entire plant.

New York City Garbage Disposal Plant.

THE handling of garbage, especially in large cities, is of great interest, not only to the municipal authorities but to the citizens. The plant illustrated herewith was designed by Charles Edgerton, Engineer of the New York Sanitary Utilization Company (the owners of the plant), and is located on Barren Island, in New York Harbor. It is here that all of New York City's garbage is consumed. One of the special features in the plant is the system of handling the garbage, as designed and erected by the



GARBAGE-DISPOSAL PLANT ON BARREN ISLAND, N. Y.

Jeffrey Manufacturing Company of Columbus, Ohio.

The garbage is brought to this plant in barges, and from these it is taken by a Jeffrey system of chain conveyors having a combined capacity for handling 150 tons per hour. The conveyor system is located in front, as will be seen from the illustration, and is arranged to carry the garbage a distance of some 300 feet up and into the digestor building. The two initial conveyors in the fore-ground are constructed of a double strand of Jeffrey steel chain, with special suspended steel flights arranged with cross arms and wearing blocks. The chains are carried on the outside of the trough and are entirely away from the material handled. There are also other systems of conveyors, seven in number, distributed through the buildings. These latter conveyors are all made with chain, flights, and fixtures adjusted to the work they are expected to do. The whole system works in harmony with the predominant idea of labor saving.

The Jeffrey Manufacturing Company are among the most extensive manufacturers of elevating and conveying devices in this country. They will be pleased to mail catalogues to any who may be interested in their line.